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ABSTRACT

This document consists of four years (40 issues) of a newsletter devoted to computers in life science education. Titles of major articles in this collection include: (1) "Good Versus Bad Software: What Makes the Difference?" (G. Kearsly); (2) "Linkway: Hypermedia for IBM Personal Computers" (L. Kheriaty); (3) "Where's the Software: Parts 1-3" (4) "Keeping Abreast of the Literature" (5) "Course of Action: CAI Software Tool for Macintosh Course Authors" (R. Heath); (6) "Microcomputer Workstations for Human Physiology Laboratories" (J. Breckler); (7) "A Comparison of Three Graphically Oriented Simulation Environments for the Macintosh" (J. Mandel), (8) "Hypertext Options for the Educational Software Developer" (J. Frkonja); (9) "Hypertext as an Authoring Environment" (H. Modell); (10) "Making 'Unsuitable' Software Suitable" (H. Modell); (11) "Constructing a Science Center in the Age of Hypermedia" (M. Koltsky); (12) "Biology Courseware for College Freshmen: The Sequel" (C. Ralph); (13) "Adapting MS-DOS Quickbasic Programs for the Macintosh" (H. Modell); (14) "Designing Protocols for Student Laboratories" (H. Modell); (15) "Where are the Videodiscs?"; (16) "Computer Programs for Memory Tests" (I. Sipinkova and J. Zahumensky); and (16) "Developing Simulations to Help Students Learn Renal Physiology" (H. Modell). (PR)

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NRCLSE

CONTENTS

GOOD VERSUS BAD SOFTWARE: WHAT MAKES THE DIFFERENCE? 1
Greg Kearsley

NRCLSE ANNUAL REPORT FOR 1988 3

THE BULLETIN BOARD 4

NRCLSE QUESTIONNAIRE 6

GOOD VERSUS BAD SOFTWARE: WHAT MAKES THE DIFFERENCE?

Greg Kearsley
Park Row, Incorporated, San Diego, California

Regardless of which computer programs are used in education, or how they are used, the design of the software will play a critical role in achieving the desired results. Programs that are difficult to use do not stand much of a chance in being accepted by students or faculty.

In the past decades, we have learned a lot about the design of good software. In fact, a relatively small number of principles account for the difference between well designed and poorly designed programs. While not every good program adheres to all of these rules, in general, the more guidelines followed, the better the quality of the program. Conversely, the fewer guidelines followed, the less likely the program will work well.

Knowing these guidelines is essential for anyone designing or evaluating instructional software. Here is a brief description of the most important principles.

SCREEN DISPLAYS

Although there is a lot more to an instructional program than the screen displays, the screens are the part of the

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software that the world sees. It is important to make them as attractive and effective as possible.

- *Don't crowd screens.* Put only a small amount of information on each screen (eg, 10-20 lines or 1 graphic). People can only absorb so much information at one time.

- *Organize your information into small "chunks".* The more you can modularize the information, the easier it will be for students to understand it.

- *Make each screen self-contained.* People have difficulty remembering things from screen to screen.

- *Use attention-getting devices s sparingly.* Blinking, bold, reverse outs, sound effects, different fonts, etc., are all good techniques for making a point, but can easily be overdone.

- *Use graphics whenever possible.* Just as in any other medium, a good illustration is worth 1000 words.

- *Use titles and headings whenever possible.* Labels help people organize and remember information.

USER CONTROL

If there is a single rule that dictates the success of any software, it is this: *the user must always be in control.* The principles in this section are all derived from this general guideline.

- *Always let the user set the pace.* People read and comprehend at different speeds. Let them, not the program, be in control of the speed.

- *Allow users to control sequencing.* Even though it runs against the grain of some instructional design theories, when it comes to software, people must be allowed to skip ahead, go back, or quit anytime they wish.

- *Provide multiple control options.* Create redundant control mechanisms (command keys, menu options, buttons) to allow for individual preferences or different levels of experience.

- *Always provide defaults.* Any option requiring a user response should have a standard choice. This saves time and avoids frustration when the user doesn't understand (or care about) the choices.

- *Let the user customize the program.* People should be able to modify or add to the interface and control options to suit their tastes.

RESPONSE ANALYSIS

- *State directions clearly.* Eliminate misunderstandings by telling users exactly what they are expected to do.

- *Always acknowledge input.* Users need to know that their responses have been recognized and processed by the system.

- *Tolerate response variation.* Design input handling routines that can cope with upper/lower case, extra spaces, or small misspellings in student input. Computers don't need to be *that* stupid.

- *Allow people to change their answers.* Since people often make inadvertent choices or change their minds, they should always be able to correct their input before it is processed.

- *Provide corrective feedback for errors.* When a student makes an incorrect response, the feedback should identify exactly what is wrong with the answer.

ERROR HANDLING/HELPS

One of the hallmarks of a well designed program is that it handles problems gracefully. This boils down to two design areas: error handling and helps.

- *Tell the user what went wrong and how to recover.* Error messages should clearly state the nature of the problem and what the user can do about it.

- *Check the range of answers.* By identifying answers that are too small, too large, or the wrong format, subsequent problems can be prevented.

- *Help should always be available.* The help options should be easy to access and available anytime. The more specific the help information, the better.

- *Provide different types of helps.* Users will need different types of help information depending upon their level of experience with the program and computers in general.

QUALITY CONTROL

Few programs work well solely on the basis of the initial design. It is usually the exhaustive process of revising and tuning that results in good software. Quality control is the name of that process.

- *Use a checklist to review programs.* Some sort of quality control checklist is needed so that the review process is systematic, not haphazard.

- *Use response data to identify problems.* Response data collected from users should be used to pinpoint programs flaws.

- *Test a program for both expected and unexpected responses.* You need to check for both the anticipated wrong answers as well as random errors caused by accidental key presses/ mouse clicks.

- *Make revisions according to a plan.* Isolated changes don't take into account interdependencies in the program. Revisions need to be thought through in terms of the entire program.

WHY ISN'T ALL SOFTWARE WELL DESIGNED?

Given that the principles of good software design can be enumerated, why

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aren't these principles followed in *all* programs? Like most guidelines, they are easier to describe than put into practice. For example, consider the rule, *use graphics whenever possible*. It takes a visual imagination to be able to translate ideas into pictures. Graphic artists have this skill, but most subject matter experts do not. To implement many of the rules having to do with response analysis and error handling, it is necessary to collect a lot of information about how students will use the program and what kinds of problems they will have. This may require data collection and analysis expertise. Unless a development team consisting of people with various specialized skills is involved, there is a good chance that certain principles will not be implemented.

In addition to special skills, the implementation of each principle takes time. Time to analyze, design, develop, debug, and test. The more rules followed, the longer the program will take to develop, and the more it will cost. Since budgets and schedules are always limited, it is not too surprising that only a limited number of principles are typically implemented in a single program. The development costs for a program that followed all of the principles above would be high. Like any other domain, you have to pay for quality.

FURTHER READING

Additional information dealing with the principles of good software design can be found in the following references:

Alessi, S and S. Trollip, Computer Based Instruction: Methods and Development. Englewood Cliffs, NJ: Prentice-Hall, 1985.

Heines, J. Screen Design Strategies for Computer-Assisted Instruction. Bedford, MA: Digital Press, 1984.

Jonassen, DH. Instructional Designs for Microcomputer Courseware. Hillsdale, NJ: Lawrence Erlbaum, 1988.

Kearsley, G. Authoring: The Design of Instructional Software. Reading, MA: Addison-Wesley, 1986.

Shneiderman, B. Designing the User Interface. Reading, MA: Addison-Wesley, 1987.

NRCLSE ANNUAL REPORT FOR 1988

The overall purpose of NRCLSE is to cultivate collaborative efforts among faculty with expertise in using computers in life science education. The broad goal of the Resource is fourfold:

1) to educate faculty in effective uses of computers in the curriculum;
2) to promote research aimed at evaluating new applications of the computer to life science education;
3) to promote development of a critical mass of high quality, versatile software; and
4) to serve in a consultant capacity for life science faculty currently active or interested in becoming active in this area.

This year's activities continued our efforts to serve the life science community. A statement of NRCLSE's financial status is presented in Table 1.

Table 1. NRCLSE Financial Report for year ending December, 1988.

Fund Balance, December 31, 1987		**$13,612**
Revenues		
Cash donations	575	
Student manuals/reprints	1,161	
CLSE Subscriptions and software sales	7,337	
Total Revenues	9,073	
Expenses		
CLSE production	5,044	
Equipment	1,331	
Contracted services	920	
Operating expenses (supplies, phone, etc)	1,688	
Total Expenses	8,933	
Fund balance, December 31, 1988		**$13,702**

GENERAL OVERVIEW OF ACTIVITIES

Publication of Computers in Life Science Education continuted to be NRCLSE's primary activity in 1988. However, during the past year, we continued to provide information to colleagues throughout the world concerning use of computers in life science curricula, participate in national meetings, and distribute our Simulations in Physiology software.

Computers in Life Science Education
Subscriptions to CLSE continued at the same level as in previous years, with close to half of the subscriptions being held by libraries. The geographic distribution of subscribers for 1988 included the U.S., Canada, Denmark, France, Great Britain, Hungary, Japan, Israel, Malta, Norway, Sweden, and West Germany.

The December, 1988 issue of CLSE marked the completion of five year's publication of the newsletter. To mark this event, Volume 5 concluded with a 5-year cumulative index.

Software distribution
In 1988, twenty-five sets of our simulations were distributed bringing the total number of distributed sets of the software to sixty-four. Institutions purchasing the software have represented a spectrum educational environments ranging from the community college level to medical schools and private hospitals.

Resource Information
During 1988, NRCLSE responded to over 50 requests for information concerning use of the computer as an educational tool. The geographic origin of the requests continues to reflect our goal of providing worldwide service. Requests this year were received from the U.S., Canada, and Europe.

Presentations/Consultation
Personnel from NRCLSE participated in a panel addressing the use of the computer as a teaching tool in a group setting at the 30th International ADCIS Conference.

NRCLSE was also invited to participate in the national panel evaluating software for the 1988 EDUCOM/ NCRIPTAL software competition.

Establishing a peer critique mechanism for software
In 1987, we began our effort to establish a peer critique mechanism for reviewing software by initiating a dialog on the topic in Computers in Life Science Education. This effort was continued in 1988 with the reprinting of the CLSE articles in Science Software, a quarterly publication serving the science community. As the year progressed, it became apparent that appropriate evaluation criteria is difficult to define without practical experience with a variety of software. Hence, rather than wait until concrete citeria are established, it was decided to initiate a peer critique mechanism and let the process evolve. NRCLSE's peer critique program was announced in the October, 1988 issue of CLSE. The program will be funded (shipping, postage, long distance phone, etc) by a $25 fee to accompany each software package to be critiqued. Reviewers will be drawn from the CLSE Colleague Directory.

Special thanks
NRCLSE extends a very special "Thank you" to the following people, organizations, and institutions for their support in 1988.

Diana J. Gabaldon, Ph.D.
Editor, *Science Software*
Center for Environmental Studies
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Tempe, AZ

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300 120th Ave.
Bldg. 1, Suite 205
Bellevue, WA 98005

THE BULLETIN BOARD

The Bulletin Board is published periodically to inform readers of upcoming meetings of interest. If you know of meetings, symposia, continuing education courses, etc, of interest to life science educators, and they do not appear in The Bulletin Board, please let us know. Send pertinent information to: Dr. Harold Modell, NRCLSE, RC-70, University of Washington, Seattle, WA 98195, or let us know via BITnet. NRCLSE's BIT net address is: MODELL@UWALOCKE.

FEBRUARY 20, 1989. Use and Development of Interactive Multi-Media in Higher Education (A Special Seminar). Kissimmee, FL.

Contact:

Learning Technology Institute
50 Culpeper Street
Warrenton, VA 22186
(800) 457-6812
In VA: (703) 347-0055

FEBRUARY 22-24, 1989. Interactive Instruction Delivery (Seventh Conference). Kissimmee, FL

Contact:

Society for Applied Learning Technology
50 Culpeper Street
Warrenton, VA 22186
(800) 457-6812
In VA: (703) 347-0055

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FEBRUARY 22-24, 1989. Learning Technology in the Health Care Sciences (Fourth Conference). Kissimmee, FL.

Contact:

Society for Applied Learning Technology
50 Culpeper Street
Warrenton, VA 22186
(800) 457-6812
In VA: (703) 347-0055

MARCH 6-8, 1989. Ninth Annual Microcomputers in Education Conference, "Interactive Technology: Unlocking Education's Connection to the Future." Tempe, AZ

Contact:

Arizona State University
Microcomputers in Education Conference
Community Services Center
Tempe, AZ 85287-0908
(602) 965-7363

MARCH 11-13, 1989. The Third National Conference for Learning Resources Centers in Schools of Nursing. Austin, TX

Contact:

School of Nursing
Continuing Education Program
The University of Texas
1700 Red River
Austin, TX 78701-1499
(512) 471-7311, ext 212

MARCH 21-23, 1989. Sixth International Conference on Technology and Education, "Education in the '90s: Challenges of the New Information Technologies," Orlando, FL.

Contact:

Jamie Alexander
Sixth I.C.T.E.
Radio Shack Education Division
1600 One Tandy Center
Fort Worth, TX 76102
(817) 390-3053

MARCH 27-29, 1989. 27th Annual Conference on the International Association for Computing in Education (IACE), "Research to Practice Through Technology," San Francisco, CA

Contact

Lajeane Thomas
IACE Program Chair
Louisiana Tech University
P.O. Box 3061, T.S.
Ruston, LA 71272
(318) 257-3923

MARCH 28-29, 1989. Sixth National Symposium on Computers in Medical Education. Omaha, NE

Contact:

Robert S. Wigton, M.D.
Department of Internal Medicine
University of Nebraska Medical Center
42nd and Dewey Avenue
Omaha, NE 68105-1065
(402) 559-7426

MAY 15-19, 1989. Medical Informatics and Education: An International Symposium, Victoria, British Columbia, Canada

Contact:

School of Health Information Science
University of Victoria
Victoria, B.C. V8W 2Y2 Canada

MAY 18-20, 1989. Rutgers College of Nursing Continuing Education Program, Sixth Annual Computer Conference held in conjunction with the American Nurses Association Council on Computer Applications in Nursing, Newark, NJ

Contact:

Gayle A. Pearson
Director of Continuing Education
Rutgers The State University
College of Nursing
Conklin Hall - Room 216
Newark, NJ 07102
(201) 648-5895

JUNE 4-6, 1989. Interactive Healthcare '89 Conference, Alexandria, VA

Contact:

Scott Stewart
Stewart Publishing, Inc.
6471 Merritt Court
Alexandria, VA 22312
(703) 354-8155

OCTOBER 16-20, 1989. Medinfo '89. The Sixth World Congress on Medical Informatics, Beijing, China

Contact:

Gao Pengyuan, M.D. or Ms. Shan Huiqin
China Medical Informatics Association
MEDINFO 89 Secretariat
55 Xueyuan Nanlu, Wei Gong Cun
Haidian District
Beijing, China 100081
P.O. Box No. 8139

OR

Phil R. Manning, M.D.
Chairman, Scientific Program Committee
MEDINFO 89
USC School of Medicine
1975 Zonal Avenue, KAM 317
Los Angeles, CA 90033
(213) 342-9370

NOVEMBER 12-16, 1989. 31st International Conference of the Association for the Development of Computer-based Instructional Systems (ADCIS), Crystal City, Washington National Airport

Contact:

ADCIS Headquarters
Miller Hall 409
Western Washington University
Bellingham, WA 98226
(206) 676-2860

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NATIONAL RESOURCE FOR COMPUTERS IN LIFE SCIENCE EDUCATION QUESTIONNAIRE

It is time once again to update our CLSE colleague directory. Please help ensure that we provide accurate information. Take a few minutes to complete the questionnaire below and fill out the software information portion for software that you have found useful in your teaching efforts. Return completed questionnaires to:

Harold Modell, Ph.D.
NRCLSE
Mail Stop RC-70
University of Washington
Seattle, WA 98195

Name: ______________________________

Address: ______________________________

______________________________ State __________ Zip ______

Phone: ____________________

What content areas do you teach? ______________________________

What student population(s) do you serve? (Please check the appropriate categories)

____ Undergraduate ____ Graduate ____ Nursing ____ Medical

____ Allied Health ____ Dental ____ Veterinary

____ Other (please specify)______________

Are you currently using the computer as an educational tool? ___Yes ___No

If yes:

How many years have you used the computer in this way? ______

What kind of equipment are you using (please check appropriate categories)

____Apple II family ____IBM or IBM compatible

____MacIntosh ____Minicomputer (please specify)______________

____Mainframe (please specify)______________

Have you written any software for use in your teaching efforts? ____Yes ____No

Would you be willing to help critique software for peers? ____Yes ___No

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Programs that have proven helpful in my teaching efforts:

Name of software:

Source of software:

Type of program:

Tutorial (Q & A) **Simulation** **Combination**

Equipment needed to run progam:

Apple II **IBM-PC** **Macintosh** **Mainframe** **Other**

Student population using software:

Undergraduate **Graduate** **Medical/Veterinary** **Dental** **Nursing**

Content area covered by this software:

How do you use this software:

Independent study **Classroom instruction** **Student laboratory**

Would you be willing to discuss your use of this program with colleagues?

Yes **No**

What do you like *best* about this software?

What do you like *least* about this software?

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should not exceed 2000 words and should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper. The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

RESPONSIBILITY AND COPYRIGHT

Authors are responsible for accuracy of statements and opinions expressed in articles. All authors submitting manuscripts will be sent a copyright transfer form to complete. The completed form must be returned before the work will be published.

SUBSCRIPTION INFORMATION

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POSTMASTER: Send address changes to *Computers in Life Science Education*, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.

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CONTENTS

LINKWAY: HYPERMEDIA FOR IBM PERSONAL COMPUTERS 9
Larry Kheriaty

WHERE'S THE SOFTWARE? - PART 1 11

LINKWAY: HYPERMEDIA FOR IBM PERSONAL COMPUTERS

Larry Kheriaty
Washington Computer Services, Bellingham, Washington

You are faced daily with the task of digesting vast quantities of information. That information is in the form of textual documents, pictures and images, graphs, video programs, voice communications, music and sound. Imagine the possibility of being able to store all that information in such a way that you can instantly retrieve any part of it when you need it. Imagine a storage medium that works the way your mind does, by association. With one idea in your grasp, you can link, by association, to any related idea. We should be able to browse through the information in different ways to suit different ends. If you had a collection of books, papers, pictures, video discs and audio recordings on the subject of space exploration, you might wish today to view all your visual images of the moon and tomorrow to construct an outline of all space travel from 1957 to 1967. Ideally, the same store of information should serve both needs.

This article is about a software product that turns a personal computer into such an information storage device. The program is called IBM LinkWay and is available from IBM Corporation. LinkWay is a "hypermedia" program; that is, it supports the storage and retrieval of data on multiple types of devices: magnetic, optical and video disc, speech and music synthesizer. In one sense, LinkWay is a database management system in which the data elements may be a mixture of text, graphics and sound. In another sense, it is a multimedia authoring system.

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The information in your mind is not just textual. Ideas are much more than strings of words. Indeed ideas are a complex mixture of what comes and goes via our senses: visual images, audio images, logical progressions, and human language. If your goal is to exchange information, you need a mechanism for representing information outside your mind in a manner that approximates how it is represented inside.

Consider the simple example of writing a research paper or report. LinkWay can be used to store and organize notes gathered from various sources. The notes can be textual or graphical. You, as the author, can store written notes, drawings, charts, and digitized pictures together in one LinkWay folder. Then you could use the built-in word processor to piece together you printed draft, along with the figures you wish to include. In this scenario, you use LinkWay to store a very loosely organized collection of data with the purpose of gradually organizing the data into a written document.

LINKWAY IS A HYPERTEXT SYSTEM

The next logical step is to take advantage of the fact that LinkWay is also a "hypertext" system. Data stored in LinkWay may be cross-referenced, or "linked" together, in a number of ways. When information is printed on paper, it is basically linear. The user reads it from start to finish in the order predetermined by the writer. A LinkWay document, called a folder, is stored as a network of data nodes and interconnections. The reader can view the information in any order that makes sense at the time. The same information that might have been published on paper, as a text document, can now be published on magnetic medium as a hypertext document. The hypertext document contains all the information that the text document contains and much more. The printed text is still present for viewing on the display screen or printing on paper. Figures such as charts, pictures, etc are still present but with the possible added dimension of animation. It is impossible to put a motion picture on paper. But LinkWay permits a folder to contain animated graphics or video scenes. The folder can also contain sound in the form of music or speech.

But the value of hypertext is that the data need not be retrieved linearly. When you store the information in a folder, you can indicate which pieces of data go together and in what manner. Then the reader of the data can use these relationships to experience the information in different ways.

To use LinkWay, you use a mouse to select the actions you need from simple pull-down menus. You do not need any special computer expertise to use LinkWay. You just point to a menu item or icon, and click the mouse button.

The organizational collection of information in LinkWay is a folder. To organize your information, you tell LinkWay you wish to create a new folder by clicking "New Folder" with the mouse. A LinkWay folder is just like a file folder you might have in your desk drawer. In it you can place any number of "pages." Each page could have whatever information on it you wish. When viewing a folder with LinkWay, you see one page of the folder at a time on the computer display screen. You can use a simple click of the mouse button to view any page in the current folder or to open another folder.

DATA ITEMS CAN TAKE VARIOUS FORMS

The individual data items you put on a page are called objects. One type of object is a test field, which can store from one word to an entire document. Another type is the picture object which is a bit- mapped image created by a paint program or by capturing a picture from another source. Both text and picture objects can be made to be visible whenever the page is showing, or invisible until the user clicks a button that makes the text o picture pop up in a window.

The most powerful type of object you can put on a page is called a "button." A button is an "action spot" that may be visible on the page as an icon, or graphic symbol. When the user clicks a button, a designated action takes place. For example, a button could link to another page that contains related information or could ask a question, call up a word processor, dial a phone, or run another program. LinkWay is provided with several "pre-programmed" buttons that you can use when building your own folders. Once a button exists, it can be cut from one page and pasted into another.

When you create your own folder, you decide exactly what objects should be on each page and what pages should be in the folder. Your folders could contain any information you wish: class notes, articles, drawings, names, addresses, customer information, collections – there is virtually no limit to the possibilities.

Authors are encouraged to publish information and programs in LinkWay format. A number of software publishers are already developing LinkWay applications for wide distribution. Included with LinkWay you get:

- hypermedia authoring environment for creating/viewing folders
- simple word processor for writing and printing text documents
- a paint program for creating graphic pictures
- a user's guide that is written for the complete beginner
- several ready-to-use folders
- some utility programs useful for the more advanced user

LinkWay is recommended for virtually every IBM-compatible computer user. For new computer owners, LinkWay is the ideal first software package since it includes every thing they need to do word processing, graphics, and

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data management. For the more experienced user, LinkWay will mean new possibilities to get even more use out of their computers.

Available separately from Washington Computer Services is the optional LinkWay Toolkit, a software library for the more technical author, and the LinkWay Technical Reference Manual.

LinkWay is available exclusively from IBM (part #6024902) for $110. LinkWay runs on any PS/2, any IBM-PC or compatible with at least 512K RAM. It supports CGA, MCGA, EGA, and VGA graphics devices. It requires a PS/2 mouse or Microsoft compatible mouse. LinkWay is also network compatible.

WHERE'S THE SOFTWARE? – PART 1

In the past, we have published lists of life science software sources and programs available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings are arranged by content area. Each item includes a vendor code relating the software to the vendors list appearing on page 15.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

ANATOMY

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment. W.3

GROSS ANATOMY TUTORIAL

Tutorial for gross anatomy review by region and for self-test in National Board format. Program available for Apple II equipment. L.2

HEART LAB

Animated graphics simulation of human heart. Program available for Apple II, TRS-80 Models I and III, PET, and Atari 800/800XL equipment. E.1

HUMAN ANATOMY PICTURE FILE

Hi-Res diagrams of heart, brain, eye, ear, respiratory system, kidney, endocrine system, neurons, circulatory system schematic, and digestive system. Program available for Apple II equipment. D.1

LOCOMOTION

Tutorial reviewing types and functions of bones and muscles. Program available for Apple II and TRS-80 Model III equipment. J.1

BIOCHEMISTRY

ANIMATED PATHWAYS OF BIOCHEMISTRY

Simulation of molecules colliding and reacting. Available for IBM-PC compatible equipment. W.3

ANIMATIONS

Contains animations for demonstrating DNA structure and synthesis, RNA structure and synthesis, and protein synthesis. Program available for Apple II equipment. E.3

BIOCHEMISTRY

Tutorial covering basic atomic structure, balancing equations, and properties of proteins and carbohydrates. Program available for Apple II and TRS-80 Model III equipment. J.1

BIOCHEMISTRY EXAM/TUTORIAL

Covers basic fuel metabolism. Available for Apple II and IBM-PC compatible equipment. W.3

CONCENTRATED CHEMICAL CONCEPTS: BIOLOGICAL CHEMIST

Drill and practice program covering an entire introductory course in organic chemistry for health science majors. W.2

DNA STRUCTURE AND SYNTHESIS

Tutorial dealing with nucleotide structure and linkage between nucleotide, base complementarity and hydrogen bonding. Program available for Apple II equipment. E.3

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced) and IBM-PC compatible equipment. E.2

ENZKIN: Enzyme Kinetics

Simulation of enzyme-catalyzed reactions. Program available for Apple II equipment. C.5

ENZLAB

Simulations for designing and carrying out enzyme kinetics experiments. Program available for Apple II and IBM-PC compatible equipment. B.1

ENZPACK

An enzyme kinetics teaching and calculation program. Program available for Apple II and IBM-PC compatible equipment. B.1

ENZYME ACTION

Tutorial on the basic nature and function of enzymes. Program available for Apple II equipment. B.1

ENZYME-SIMULATION, ENZYME ACTION

Simulation of enzyme action and the effects of inhibitors using acetylcholinesterase. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

GENE MACHINE

Tutorial/Simulation dealing with DNA replication and protein synthesis. Program available for Apple II equipment. H.2

MOLECULAR BIOLOGY SERIES
Programs demonstrating central processes of RNA and protein synthesis and DNA synthesis and repair. Program available for Apple II and IBM-PC compatible equipment. B.1

MOLGRAF
Molecular graphics package. Program available for Apple II and IBM-PC compatible equipment. B.1

THE NUCLEIC ACIDS
Tutorial/Simulation dealing with principal nucleotides and synthesis of RNA. Program available for Apple II equipment. E.2

PROTEIN SYNTHESIS
Tutorial dealing with the general structure of the amino acids and formation of peptide bonds. Program available for Apple II equipment. E.3

RNA STRUCTURE AND SYNTHESIS
Tutorial extending the concept of hydrogen bonding between complementary bases to show the synthesis of RNA on the DNA template and the analogies in structure between DNA and RNA. Program available for Apple II equipment. E.3

BIOLOGY

ADAPTION AND IDENTIFICATION
Tutorial covering animal adaptation to different environments and animal identification. Program available for Apple II equipment. S.1

ANIMAL REPRODUCTION
Tutorial reviewing sperm development, egg and fertilized egg. Program available for Apple II and TRS-80 Model III equipment. J.1

ASEXUAL REPRODUCTION
Tutorial reviewing cell division. Program available for Apple II and TRS-80 Model III equipment. J.1

BIOLOGY 1/BIOLOGY 2
Tutorials covering a wide range of topics in biology. Available for IBM-PC compatible equipment. I.3

BIOLOGY COMPUTER STIMULATIONS
Tutorial covering various biological concepts and experimental areas including enzymes, photosynthesis, respiration, diffusion, meiosis, muscles, nerves, and genetics. Program available for Apple II and TRS-80 Models I and III equipment. L.2

BIOLOGY DISSECTION FROG
Dissection guide that teaches students how to dissect a frog. Available for Apple II compatible equipment. C.7

BIOLOGY LAB DISSECTIONS
Seven dissection guides teach students about seven different animals: Frog, Earthworm, Grasshopper, Crayfish, Starfish, Clam and Perch. Available for Apple II compatible equipment. C.7

BIOLOGY SIMULATIONS PACKAGE III
Three collections of simulations covering aspects of genetics, natural selection, and predator-prey interaction. Available for Apple //e (enhanced) equipment. A.3

CREATE A TEST/CREATE A TEST QUESTION FILES-BIOLOGY
Test creation program and 4800 question bank in biology. Available for Commodore 64, Apple II and IBM-PC compatible equipment. C.7

DIFFUSION AND ACTIVE TRANSPORT
Tutorial covering diffusion, osmosis, and active transport in biological systems. Program available for Apple II equipment. S.3

ENERGETICS AND METABOLISM, GARDEN OF BIOLOGY: VOLUME I
Data base illustrating reactions of metabolism and interactions between the several metabolic compartments of a cell. Program available for Macintosh equipment. K.1

EVOLUTION, GARDEN OF BIOLOGY: VOLUME 2
Data base illustrating relations among organisms of many kinds, emphasizing the history and mechanics of their evolutionary change. Program available for Macintosh equipment. K.1

FASCINATING STORY OF CELL GROWTH
Tutorial covers surface area/cell volume, experimenting with cell size, chromosomes in cell division and stages of mitosis. Available for IBM-PC compatible equipment. T.1

HOW'S AND WHY'S OF MIGRATING MOLECULES
Tutorial covering transport through a membrane, osmosis and diffusion. Available for IBM-PC compatible equipment. T.1

HUNTINGTON I SIM PROG - BIOLOGY
Seven simulations for use in introductory level biology courses. Available for DEC equipment. H.3

KNOWLEDGE MASTER - BIOLOGY 2
Test-item database for test generation. Content covers coelenterates, arthropods, insects, fish, amphibians, and reptiles. Part of a 5-program Biology series for Apple II equipment. A.1

KNOWLEDGE MASTER - BIOLOGY 3
Test-item database for test generation. Content covers birds, mammals, primates, protists, bacteria and taxonomic zoology. Part of a 5-program Biology series for Apple II equipment. A.1

OSMO- OSMOSIS IN RED BLOOD CELLS
Simulation of red blood cells in hypertonic, hypotonic, and isotonic solutions. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. D.2

OSMOSIS AND DIFFUSION
Tutorial/Simulation covering effects of temperature, concentration, solubility, molecule size and charge, and membrane pore size on flow of matter across semi-permeable membranes. Program available for Apple II, TRS-80 Models I and III equipment. E.2

OSMOTIC PRESSURE
Simulation of thistle tube experiments and animation of a molecular model for osmosis. Program available for Apple II equipment. C.5

PASSIVE TRANSPORT
Tutorial-simulation covering diffusion and osmosis. Program for MS-DOS compatible equipment. C.1

SIMULATION OF HEMOGLOBIN FUNCTION
Simulations of hemoglobin and myoglobin functions. Program for Apple II equipment. C.3

BOTANY

ALGAL GROWTH
Simulation of the effects of eight variables on growth of algae. Program

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available for Apple II and IBM-PC compatible equipment. O.1

BIOLOGY FRUIT KEY

Identifies 125 trees and shrubs. Program available for Atari 400/800 equipment. D.4

COMPETE:Plant competition

Simulation of experiments involving interaction between flowering plants. Program available for Apple II equipment. C.5

EXPLORING THAT AMAZING FOOD FACTORY, THE LEAF

Tutorial covers transport in the leaf, structure of the leaf and stomate action in gas exchange. Available for IBM-PC compatible equipment. T.1

FAMILY IDENTIFICATION

Data retrieval program to review the characteristics of 74 North American flowering plant families. Program available for Apple II equipment. C.5

HOW PLANTS GROW: THE INSIDE STORY

Tutorial covers growth of the plant, stem cross section, terminal bud and plant hormones. Available for IBM-PC compatible equipment. T.1

LEAF: STRUCTURE AND FUNCTION

Tutorial-simulation covering the anatomy and physiology of the leaf with respect to its role as the "chemical factory" of the plant. Program for IBM-PC (PC-DOS). C.1

PHOTOSYNTHESIS AND LIGHT ENERGY

Simulation focuses on characteristics of light and its role as an energy source. Program for IBM-PC (PC-DOS). C.1

PHOTOSYNTHESIS AND RESPIRATION

Demonstration and simulations focusing with light and dark reactions of photosynthesis, respiration, and ATP cycle. Program available for Apple II equipment. S.1

PHOTOSYNTHESIS & TRANSPORT

Tutorial dealing with photosynthesis and transport in plants. Program available for Apple II and TRS-80 Model III equipment. J.1

PHOTOSYNTHESIS: UNLOCKING THE POWER OF THE SUN

Tutorial includes light as energy, light characteristics, wave length of light used by chromoplasts, variables and controls. Available for IBM- PC compatible equipment. T.1

PLANT ANATOMY PICTURE FILE

Hi-Res diagrams of roots, stem cross-section, leaf cross-section, photosynthesis, flowers, seeds, and germination. Program available for Apple II equipment. D.1

PLANT CELL CYCLE

Hypercard stack illustrating plant cell division. Available for Macintosh equipment. K.1

PLANT GROWTH

Tutorial-simulation covering physiology of growth beginning with the seed. Covers hormone control, feedback mechanisms, transport, and differentiation. Program for IBM-PC (PC-DOS). C.1

PLANT PAINT

A set of 36 graphics images illustrating concepts in plant biology. Available for Macintosh equipment. K.1

PLANT-PLANT GROWTH SIMULATION

Simulation of the effects of light intensity and duration on growth and development of green plants. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

REPRODUCTION IN PLANTS

Tutorial reviewing asexual and sexual reproduction in plants. Program available for Apple II and TRS-80 Model III equipment. J.1

SOLAR FOOD

Tutorial/Simulation dealing with photosynthesis. Program available for Apple II equipment. H.2

CLINICAL MEDICINE

ABG PRACTICE/THE ABG TEACHER

Drill and practice and tutorial programs dealing with acid/base evaluation. Available for Apple II and IBM- PC compatible equipment. M.2

ALCOHOL ABUSE AND ALCOHOLISM

Set of eight patient-management problems simulating the treatment of patients with alcohol related problems. Available for Apple II and IBM- PC compatible equipment. U.1

ARRHYTHMIAS: CASE STUDIES IN MANAGEMENT

Simulated patients with various cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. W.3

ARRHYTHMIAS TUTORIAL I/ TUTORIAL II

Tutorial dealing with all major cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. W.3

ARTERIAL BLOOD GASES

Tutorial dealing with the interpretation of arterial blood gases. Available for Apple II and IBM- PC compatible equipment. W.3

BLANCHAER CLINICAL CASE STUDIES

Eight simulations of clinical syndromes. Program available for Apple II equipment. B.1

BLOOD COUNTS & DIFFERENTIAL EVALUATION – TEACHING MODULE

Test proficiency in the interpretation of blood counts. Available for IBM-PC compatible equipment. L.1

CARDIOLOGY

Study/review package dealing with various aspects of cardiovascular disease. Available for Apple II and IBM-PC compatible equipment. U.1

CHEST PAIN: AN EXERCISE IN CLINICAL PROBLEM SOLVING

Patient management problems dealing with chest pain. Available for Apple II and IBM-PC compatible equipment. W.3

CLINICAL SCIENCES

Self-assessment package covering internal medicine, ob/gyn, pediatrics, preventive medicine and public health, psychiatry, and surgery. Available for Apple II and IBM-PC compatible equipment. U.1

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. N.3

GAS MAN

Simulation of uptake and distribution of inhalation anesthetics in a 70 kg subject. Available for Apple II compatible equipment. M.1

GASMAN

Simulation dealing with inhalation gas uptake. Available for Apple II compatible equipment. A.2

MED-CAPS DIAGNOSTIC PROBLEM SOLVING CASES/MANAGER

Case simulations covering a wide range of clinical problems. The manager consists of a set of programs for monitoring student use and performance on the diagnostic problems. Available for Apple II and IBM-PC compatible equipment. H.1

THE SURGEON

Simulation of surgical correction of an aortic aneurysm. Available for Macintosh equipment. I.2

CYTOLOGY

CELL CHEMISTRY I

Tutorial covering various chemical structures. Program available for Apple II and IBM-PC compatible equipment. S.4

CELL CHEMISTRY II

Tutorial covering the chemical and physical processes that occur within cells. Program available for Apple II and IBM-PC compatible equipment. S.4

CELLGROW

Simulation of cell kinetics. Program available for Apple II equipment. U.2

CELL GROWTH AND MITOSIS

Interactive simulation covering surface area-volume ratio, chromosome number, chromosome replication, and cytoplasmic division. Program for IBM-PC (PC-DOS). C.1

CELLS: STRUCTURE AND FUNCTION

Simulation reinforces basic concepts of cell structure, cell functions, water movement and concentration gradients, and diffusion and active transport. Program available for Apple II equipment. S.1

ECOLOGY

AIR POLLUTION

Simulation of carbon monoxide pollution in an urban environment. Program available for Apple II and TRS-80 Model I and III equipment. E.2

AQUATIC ECOLOGY

Utilities to perform many of the calculations common to aquatic ecology. Program available for Apple II and IBM-PC equipment. O.1

AQUATIC ECOLOGY DATA SIMULATION

25 simulations covering aquatic systems. Program available for Apple II and IBM-PC equipment. O.1

ECOLOGICAL DATA SIMULATION

25 simulations covering ecological systems. Program available for Apple II and IBM-PC equipment. O.1

ECOLOGY

Rote drill reviews and reinforces concepts of general terrestrial, and aquatic ecology. Available for Apple II and IBM-PC compatible equipment. S.4

ECOLOGY

Simulation dealing with plant population sizes and growth pattern. Available for Apple II equipment. S.1

ECOLOGICAL ANALYSIS - PC

Utilities that perform life table analysis, interspecific association indices, community similarity, diversity indices, descriptive statistics, mark-release recapture analysis, plus regression and correlation analysis. Program available for IBM-PC compatible equipment. O.1

ECOLOGICAL ANALYSIS VOL. 2 - PC

Utilities that perform community similarity analysis, indices of dispersion, species-area curve, and step-wise multiple regression. Program available for IBM-PC compatible equipment. O.1

ECOLOGICAL ANALYSIS PROGRAMS PLUS

Utilities that perform life table analysis, community similarity indices, diversity indices, predator-prey modeling, mark-recapture analysis, descriptive statistics, plus regression and correlation analysis. Program available for Apple II equipment. O.1

ECOLOGICAL MODELING

Series of 7 programs dealing with a variety of techniques for modeling ecological systems and processes. Program available for Apple II and IBM-PC compatible equipment. C.5

NICHE-ECOLOGICAL GAME/ SIMULATION

Game in which students attempt to place an organism in its proper ecological niche correctly by specifying environment, range, and competitor. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

POLLUTE

Simulation of factors affecting water quality. Includes temperature, amount and type of pollutant, and water treatment. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. C.4

POLLUTE:IMPACT/WATER POLLUTANTS

Simulation of the impact of various pollutants on typical bodies of water. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

WATER POLLUTION

Simulation of the effects of temperature, type of waste, dumping rate, and method of treatment on the impact of pollution on aquatic life. Program available for Apple II, TRS-80 Models I and III equipment. E.2

EVOLUTION

EVOLUT: Evolution and Natural Selection

Simulation of fluctuations in gene frequenceis of wild populations. Program available for Apple II equipment. C.5

EVOLUTION

Simulations covering mutation, gene flow, natural selection, and genetic drift on populations. Program available for Apple II and IBM-PC compatible equipment. O.1

EVOLVE

Simulation of evolution using the Hardy-Weinberg formula and the population model that has evolved from its application. Available for Apple II equipment. C.5

FORESTRY

FOREST FIRE DISPATCHER

Simulation dealing with a ranger district during the forest fire season. Available for TRS-80 III equipment. D.3

FOREST SAMPLE DATABASE

Two program set that allows development of a database from either variable radius plots or fixed radius plots. Available for TRS-80 I and TRS-80 III equipment. D.3

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VENDORS

A.1 Academic Hallmarks
P.O. Box 998
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(303) 247-8738

A.2 Addison-Wesley Publishing Co
390 Bridge Parkway
Redwood City, CA 94061
(415) 594-4400

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562 Boston Avenue
Bridgeport, CT 06610
(203) 335-0908

B.1 BIOSOFT
22 Hills Road
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Milltown, NJ 08850

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Iowa City, IA 52242
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P.O. Box 1980
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W.1 Walker, Dr. J.R.
University of Texas Medical Branch
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W.2 Wiley Professional Software
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NRCLSE

CONTENTS

KEEPING ABREAST OF THE LITERATURE 17

WHERE'S THE SOFTWARE? – PART 2 18

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WHERE'S THE SOFTWARE? – PART 2

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor code relating the software to the vendors appearing ar the end of the software lists.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future Where's the Software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195 or send us a note on BITnet. Our BITnet address is MODELL@ UWALOCKE.

GENETICS

ADVANCED GENETICS

Tutorial/Simulation presented as a nine-part program covering dominance and recessiveness, partial dominance, lethality, mechanism of inheritance, multiple alleles, sex linkage, multi-trait inheritance, crossing over, and gene mapping. Program available for Apple II equipment. E.2

CATGEN

Simulation allowing students to mate domestic cats of known genotypes. Program available for Apple II and IBM-PC compatible equipment. C.5

CATLAB (Second Edition)

Simulation in introductory genetics. Program available for Apple II and IBM-PC compatible equipment. C.5

CELLS AND GENETICS PICTURE FILE

Hi-Res diagrams of animal cell, plant cell, mitosis, meiosis, Punnett Square, sex linked traits, DNA replication, protozoa, energy reactions, and pedigree. Program available for Apple II equipment. D.1

DICROSS-DIHYBRID CROSSES

Simulation of various types of dihybrid crosses. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

DNAGEN-DNA/GENETIC CODE SIMULATION

Simulation of genetic code to produce protein sequences. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced) and IBM-PC compatible equipment. E.2

DNA - THE MASTER MOLECULE

Simulation dealing with DNA structure. Programs available for Apple II equipment. E.2

FLYGEN

Simulation of monohybrid or dihybrid crosses with 25 varieties of Drosophila. Program available for Apple II,

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TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

GENESIM

Simulations of experminents in bacterial and molecular genetics. Program available for Apple II and IBM-PC compatible equipment. B.1

GENETIC ENGINEERING

Contains two gene base sequences plus an option to enter a custom gene, comparing changes to the normal gene. Available for Apple //e (enhanced) and IBM-PC compatible equipment. E.2

GENTIC DRIFT

Tutorial-simulation focusing on random changes with time in the distribution of individuals in small populations. Program for Apple II equipment. C.3

GENETICS

Tutorial covering various crosses in plants and fruit fly populations. Program available for Apple II and TRS-80 Model III and IV equipment. J.1

GENETICS

Tutorial that allows students to explore Mendel's experiments, Punnett Squares, sex linkage in fruit flies, and multiple alleles. Program available for Apple II equipment. S.1

GENETICS

Tutorial examines DNA molecule and progresses to applied genetics. Program available for Apple II and IBM-PC compatible equipment. S.4

HEREDITY DOG

Tutorial covering various genetic topics. Program available for Apple II and Commodore 64/128 equpiment. H.2

HUMAN GENETIC DISORDERS

Simulation investigating inherited disorders. Program available for Apple II equipment. H.2

INTRODUCTORY GENETICS

Three part tutorial covering a variety of topics. Program available for Apple II, TRS-80 Models I and III equipment. E.2

LIFE

Educational game dealing with changing distributions of individuals. Program for Apple II equipment. C.3

LINKOVER: Genetic Mapping

Simulation of genetic mapping experiments. Program available for Apple II equipment. C.5

MEIOSIS

Tutorial/Simulation providing an interactive portrayal of gamete formation. Program available for Apple II and IBM-PC equipment. E.2

MEIOSIS, MITOSIS, PROTEIN SYNTHESIS

Simulation demonstrating mitosis, meiosis, DNA replication, and protein synthesis. Program available for Apple II equipment. S.1

MENDELIAN GENETICS

Simulation covering dominance, partial dominance, lethatlity, linkage, and sex linkage. Program for Apple II equipment. C.3

MONOCROS-MONOHYBRID CROSSES

Simulation of various monohybrid genetic crosses. Program available for Apple II, TRS-80 models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

NATURAL SELECTION

Tutorial/Simulation dealing with genetics and evolution to populations. Program available for Apple II equipment. E.2

POPGEN-POPULATION GENETICS

Simulation of the effects of Hardy-Weinberg Law conditions on gene, genotype, and phenotype frequencies of a population over time. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

MICROBIOLOGY

DILUTE-MICROBIAL DILUTION SERIES

Simulation covering design and testing of microbial dilution series to determine concentration of a bacterial solution. Program available for Apple II, TRS-80 Model III, IBM-PC, Commodore 64/128 equipment. D.2

MICROBIOLOGY TECHNIQUES

Tutorial/Simulation covering various laboratory procedures. Program available for Apple II equipment. E.2

NEUROSCIENCE

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment. W.3

NEUROMUSCULAR CONCEPTS

Tutorial covering muscle action potentials, use of electromyograph, contraction, muscle action and movement disorders. Program for Apple II equipment. B.2

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. B.1

NURSING

For an extensive list of educational software for nursing, consult the Directory of Educational Software for Nursing published annually by the National League of Nursing, 10 Columbus Circle, New York, NY 10019. (800) 847-8480 and Annual software exchange published in Computers in Nursing (March/April, 1988 Supplement)

PHARMACOLOGY

CARDIAC PHARMACOLOGY

Simulation of cardiac activity in response to a variety of pharmacological agents. Available for IBM-PC compatible equipment. W.1

CARDIOLAB

Simulation of cardiovascular pharmacology experiments. Available for BBC C, Apple II, and IBM-PC compatible equipment. B.1

EFFECTS OF DRUGS ON THE UTERUS AND THE INTESTINE

Simulation of uterine activity and intestinal smooth muscle. Available for IBM-PC compatible equipment. W.1

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ILEUM

Simulates laboratory experiments investigating effects of drugs on the in vitro guinea pig ileum. Program available for Apple II and IBM-PC compatible equipment. B.1

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. A.4

MACDOPE

Simulation dealing with absorption, distribution, metabolism, and elimination of drugs. Available for IBM-PC compatible equipment. I.4

PHARMACOKINETICS

Simulation for one-compartment and two-compartment models. Available for IBM-PC compatible equipment. C.6

PHARMATUTOR

Five short class exercises that include pharacokinetic simulations, effects of agents on the cardiovascular system, and regulators of smooth muscle function and neuromuscular transmission. Available of Macintosh equipment. F.1

PRINCIPLES OF PHARMACOLOGY

Tutorial covering history, drug absorption and distribution, biotransformation and elimination, mechanisms of action, and drug safety and efficacy. Program for Apple II equipment. B.2

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. W.1

PHYSIOLOGY

ABGAME

Tutorial and game providing practice in acid-base principles. Program available for IBM-PC compatible equipment. N.3

ACID-BASE PHYSIOLOGY SIMULATION

Simulation of acid-base disturbances based on Davenport Diagram. Program available for IBM-PC compatible equipment. I.1

ARTWAVE: THE RADIAL ARTERY PRESSURE WAVEFORM

Simulation dealing with factors influencing the shape of the radial arterial pressure waveform. Available for IBM-PC compatible equipment. A.4

BALANCE: MYOCARDIAL OXYGEN SUPPLY AND DEMAND

Simulation of the cardiovascular system predicting myocardial oxygen supply and demand. Available for IBM-PC compatible equipment. A.4

BASIC HUMAN

Integrated systems model of human physiology. Program available for IBM-PC compatible equipment. R.1

BIOFEEDBACK

Part of 10 program package Experiments in Human Physiology. Experiments include biofeedback, conditioning, and perception measurements. Program available for Apple II equipment. H.2

BIOFEEDBACK MICROLAB

Package includes a pulse rate sensor that measures EMG, a thermistor probe to measure skin temperature, and an interface circuit that enables student to connect the sensors to the computer. Program available for Apple II and Commodore 64/128 equipment. H.2

THE BODY IN FOCUS

Tutorial for investigating body systems including skeletal, muscular, respiratory, cardiovascular, gastrointestinal, endocrine, and integumentary. Available for Apple II and IBM-PC compatible equipment. N.2

CALIBRATION

Part of 10 program package Experiments in Human Physiology. Temperature and timing functions are calibrated against standards. Program available for Apple II equipment. H.2

CAPEXCH

Simulation dealing with exchange at the capillary level. Available for IBM-PC compatible equipment. N.3

CARDIAC MUSCLE MECHANICS

Simulation of heart muscle behavior in response to changes in length, load, and contractility. Available for IBM-PC compatible equipment. C.3

CARDIOVASCULAR FITNESS LAB

Provides students with everything they need in order to use the microcomputer to monitor cardiovascular activity. Program available for Apple II and Commodore 64/128 equipment. H.2

CARDIOVASCULAR INTERACTIONS

Cardiovascular Physiology simulation. Program available for IBM-PC compatible equipment. I.1

CARDIOVASCULAR PHYSIOLOGY PART I: PRESURE/FLOW RELATIONS

Tutorial dealing with a variety of calculations in the area of hemostatics/ hemodynamics. Program available for IBM-PC compatible equipment. R.2

CARDIOVASCULAR PHYSIOLOGY PART II: REFLEX

Tutorial dealing with carotid sinus regulation of blood pressure, and reflex responses in hemorrhage and exercise. Program available for IBM-PC compatible equipment. R.2

CARDIOVASCULAR SYSTEMS AND DYNAMICS

Simulation of aspects of cardiovascular physiology. Includes an isolated heart laboratory, heart-lung laboratory, systemic circulation laboratory, and a full circulatory system. Available for IBM-PC compatible equipment. C.2

CIRCSIM: A TEACHING EXERCISE ON BLOOD PRESSURE REGULATION

Simulated experiment based on a model of the baroreceptor reflex loop. Program available for IBM-PC compatible equipment. R.2

CIRCSYST

Simulation of hemodynamics. Available for IBM-PC compatible equipment. N.3

CONCEPTS IN THERMOGRAPHY

Tutorial covering basic DC concepts, peripheral vascular physiology, detecting skin temperature, amplifiers, and processing DC signals. Program for Apple II equipment. B.2

DIGESTION

Tutorial covering digestion in simple organisms and humans. Program available for Apple II and TRS-80 Model III equipment. J.1

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. N.3

ENDOCRINE SYSTEM

Tutorial covering hormones, effects and problems. Program available for Apple II and TRS-80 Model III equipment. J.1

EXCRETION

Tutorial reviewing metabolic wastes, waste removal, and kidney function. Program available for Apple II and TRS-80 Model III equipment. J.1

EXERCISE EXPERIMENTS

Part of 10 program package Experiments in Human Physiology. The effect of exercise and physical condition on heart rate, breathing rate, and skin temperature is investigated. Program available for Apple II equipment. H.2

GAS DIFFUSION IN THE LUNG

Simulation of oxygen and CO2 transfer between alveolar air and blood. Program available for IBM-PC compatible equipment. I.1

HEART RATE

Part of 10 program package Experiments in Human Physiology. Light and light sensor for measuring and recording heart rate. Program available for Apple II equipment. H.2

HOMEOSTASIS-THERMOREGULATION

Part of 10 program package Experiments in Human Physiology. Students investigate the body's ability to maintain a constant internal temperature by subjecting a volunteer to mild temperature excursion while recording and displaying skin and body temperature. Program available for Apple II equipment. H.2

HUMAN BODY-STRUCTURE AND FUNCTION

Simulation covering joint movement, movement of food through digestive system, and enzyme activity. Program available for Apple II equipment. S.1

HUMAN CIRCULATORY SYSTEM

High resolution pictorial simulation. Available for Apple //e (enhanced) and IBM-PC compatible equipment. E.2

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. A.4

MACMAN

Simulation of circulatory system. Available for IBM-PC compatible equipment. I.4

MACPEE

Simulation of interactions of renal physiology. Available for and IBM-PC compatible equipment. I.4

MACPUF

Simulation of cardiopulmonary physiology. Available for IBM-PC compatible equipment. I.4

MECHANICAL PROPERTIES OF ACTIVE MUSCLE

Set of six programs concerned with skeletal muscle contraction. Available for IBM-PC compatible equipment. C.3

MODEL NEURON

Simulation of the behavior of an isolated neuron. Program available for Macintosh equipment. K.1

MUSCLE MECHANICS: A COMPUTER-SIMULATED EXPERIMENT

Simulated experiment that permits the user to determine either the length-tension or the force-velocity relationship of a skeletal muscle. Program available for IBM-PC compatible equipment. R.2

NERVOUS SYSTEM

Tutorial covering nerves, reflexes, and chemical transfer of impulses. Program available for Apple II and TRS-80 Model III equipment. J.1

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. B.1

PHYSIOLOGICAL DATA SIMULATION

25 simulations covering aspects of physiology. Program available for Apple II and IBM-PC compatible equipment. 0.1

PROBLEMS IN FLUID COMPARTMENT RE-DISTRIBUTION

Tutorial covering solution of simple problems of fluid compartment changes in the face of perturbations. Program available for IBM-PC compatible equipment. R.2

PSYCHOLOGICAL STRESS-LIE DETECTOR

Part of 10 program package Experiments in Human Physiology. The physiological response to the stress of a frustrating and abusive quiz is measured. Program available for Apple II equipment. H.2

PULMONARY MECHANICS

Tutorial and simulation dealing with pulmonary mechanics. Available for IBM-PC compatible equipment. N.3

PULMONARY MECHANICS LAB

Simulation of respiratory mechanics. Available for IBM-PC compatible equipment. C.2

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. W.1

RESPIRATION RATE

Part of 10 program package Experiments in Human Physiology. A napping subject is monitored for heart and breathing rate. Results are compared to the data acquired when the subject is awake. Program available for Apple II equipment. H.2

RESPONSE-TIME

Part of 10 program package Experiments in Human Physiology. Users measure finger reaction times with a bright light stimulus (sensor included). Program available for Apple II equipment. H.2

RESPONSE-TIME INVESTIGATIONS

Part of a 10 program package Experiments in Human Physiology. The effects on reaction times of stimulus type and response location are studied. Program available for Apple II equipment. H.2

RESPSYST, GASEXCH

Simulations dealing with pulmonary

gas exchange. Available for IBM-PC compatible equipment. N.3

SIMULATIONS IN PHYSIOLOGY - THE RESPIRATORY SYSTEM

Series of 12 simulations dealing with respiratory mechanics, gas exchange, chemoregulation and acid-base balance. Program available for Apple II, IBM-PC compatible, and Macintosh equipment. N.1

SKELETAL MUSCLE ANATOMY/ PHYSIOLOGY

Tutorial covering three muscle categories, skeletal muscle microstructure, sliding filament theory, motor units, and lever systems. Program for Apple II equipment. B.2

SKELETAL MUSCLE CONTRACTIONS

Tutorial/Simulation of muscle mechanics. Available for IBM-PC compatible equipment. S.2

SKELETAL MUSCLE MECHANICS

Set of six simulations dealing with muscle physiology. Program available for IBM-PC compatible equipment. I.1

SKILLS IN ELECTROMYOGRAPHY

Tutorial covering skin preparation, reducing EMG artifact, testing a myograph's operation, electrode location, and preventing shock hazards. Program for Apple II equipment. B.2

SKIN TEMPERATURE

Part of a 10 program package Experiments in Human Physiology. Temperature probe (included) senses body and skin temperatures. Program available for Apple II equipment. H.2

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should not exceed 2000 words and should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper. The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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EDUCATION

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NRCLSE

CONTENTS

WHERE'S THE SOFTWARE? – PART 3 25

CAN YOU HELP? 28

NRCLSE SOFTWARE EVALUATION SUBMISSION FORM 29

WHERE'S THE SOFTWARE? – PART 3

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor code relating the software to the vendors appearing ar the end of the software lists.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future Where's the Software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195 or send us a note on BITnet. Our BITnet address is MODELL@ UWALOCKE.

POPULATION DYNAMICS

BALANCE-PREDATOR-PREY SIMULATION

Simulation of the effects of food supply, carrying capacity, environmental conditions, and external pressures or predator/prey relationships. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

COEXIST:Population Dynamics

Simulation of the growth of two populations either independently or in competition for the same limited resources. Program available for Apple II equipment. C.5

COMMUNITY DYNAMICS

Tutorial/simulation dealing with interaction of predator and prey systems.

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Available for Apple //e equipment. E.2

ISLAND BIOGEOGRAPHY

Three simulations of island communities dealing with the relationship between island area and number of species, colonization of a new island, and island immigration and extinction. Program available for Apple II equipment. C.5

LIMITS

Simulation of the effects of growth on world population, pollution, food supply, industrial output, and natural resources. Program available for Apple II, PET/CBM and TRS-80 Model III equipment. C.4

MARK & RECAPTURE

Simulation of mark and recapture experiments to explore three models for estimating population sizes. Program available for Apple II equipment. C.5

POP

Simulation of three growth models (exponential, logistical, and logistical with low density). Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. C.4

POPGRO-POPULATION GROWTH SIMULATION

Simulation of unlimited growth (J-curve), limited growth (S-curve) and limited growth with response lag time (S-curve with oscillations) models of population growth. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. D.2

POPULATION CONCEPTS

Simulation dealing with factors influencing population growth. Available for Apple //e, TRS-80 4, and TRS-80 III equipment. E.2

POPULATION FLUCTUATIONS

Tutorial covering factors influencing population growth. Program available for Apple II, TRS-80 Models I and III equipment. E.2

POPULATION GROWTH

Simulation dealing with exponential and density-dependent gowth. Program for Apple II equipment. C.3

POPULATION GROWTH

Simulation of population growth. The package compares and contrasts the geometric or exponential growth model with the logistic or Verhulst-Pearl growth model. Program available for Apple II equipment. C.5

POPULATON SIZES

Simulation dealing with a dynamic population. Program for Apple II equipment. C.3

PREDATION

Simulation of predator-prey interactions. Program available for Apple II equipment. C.5

PREDATION EQUILIBRIA

Simulations of equilibrium models of predator-prey interaction. Program available for Apple II equipment. C.5

RABBITS

Wildlife population simulation. Available for TRS-80 III equipment. D.3

SUBSTANCE ABUSE

DRINKING AND NOT DRINKING

Tutorial designed to augment strategies for the prevention of substance abuse. Includes facts about drinking and the effects of alcohol. Program available for Apple II equipment. K.1

INTRODUCTION TO PSYCHOACTIVE DRUGS

Tutorial designed to augment strategies for the prevention of psychoactive drug abuse. Program available for Apple II equipment. K.1

KEEP OFF THE GRASS

Tutorial designed to augment strategies for the prevention of marijuana abuse. Program available for Apple II equipment. K.1

SIX CLASSES OF PSYCHOACTIVE DRUGS

Tutorial designed to augment strategies for the prevention of psychoactive drug abuse. Program available for Apple II equipment. K.1

SUBSTANCE ABUSE DATA BASE

Database containing contact information on substance abuse organizations. Program available for Apple II equipment. K.1

ZOOLOGY

ZOOLOGY I

Tutorial covering the general characteristics, structures, and functions that define the major invertebrate phyla. Program available for Apple II and IBM-PC compatible equipment. S.4

ZOOLOGY II

Tutorial covering physiology in the Phylum Chordata. Program available for Apple II and IBM-PC compatible equipment. S.4

MISCELLANEOUS

BAFFLES, BAFFLES II

Game to help students develop deductive reasoning and problem solving skills. Program available for Apple II (BAFFLES) and IBM-PC compatible (BAFFLES II) equipment. C.5

BASIC SCIENCES

Self-assessment package covering anatomy, behavioral science, biochemistry, microbiology, pathology, pharmacology, and physiology. Available for CP/M and IBM- PC compatible equipment. U.1

CLASSIFY-CLASSIFICATION KEY PROGRAM

Presents an unclassified set of characteristics and labels for classification at various levels. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. D.2

GRADE KEEPER - PC

Grade book manager that handles classes up to 300 students, up to 25 grades per student. Program available for IBM-PC compatible equipment. O.1

GRADEBK

Program for the analysis of a large set of grades. Program available for IBM-PC compatible equipment. I.1

LABPLOT

Allows the Apple II with any A/D converter card to be used as a multipen chart recorder or as an X/Y plotter. B.1

LIFE TABLES AND THE LESLIE MATRIX

Tutorial-simulation dealing with the basic life table and Leslie Matrix. Program available for Apple II equipment. C.5

MALARIA

Simulation of the effects of various types of malaria epidemic controls. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. C.4

MULTI-Q

A general purpose question creation

and presentation system. Program available for Apple II and IBM-PC compatible equipment. B.1

"Q" EDUCATIONAL AUTHORING SYSTEM

Authoring system for tutorial and assessment material. Allows incorporation of graphics and videodisc material. Program available for IBM-PC compatible equipment. B.1

RATS

Simulation of rat control in city or apartment by sanitation and various poisons. Program for Apple II, PET/CBM, and TRS-80 Model III equipment. C.4

STERL

Simulation exploring effectiveness of pest control methods. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. C.4

TRACER AUTHORING SYSTEM

Designed for faculty use to develop diagnostic case simulations in any branch of medicine. Available for IBM-PC compatible equipment. H.1

TRIBBLES, TRIBBLES Revisited

Simulation to introduce students to the scientific method. Programs available for Apple II (Tribbles) and IBM-PC compatible (Tribbles revisited) equipment. C.5

VENDORS

A.1 Academic Hallmarks
P.O. Box 998
Durango, CO 81301
(303) 247-8738

A.2 Addison-Wesley Publishing Co
390 Bridge Parkway
Redwood City, CA 94061
(415) 594-4400

A.3 Albion
Division of Queue Inc
562 Boston Avenue
Bridgeport, CT 06610
(203) 335-0908

A.4 AneSoft Corporation
13051 SE 47th Place
Bellevue, WA 98006
(206) 644-7488

B.1 BIOSOFT
22 Hills Road
Cambridge CB2 1JP, United Kingdom

P.O. Box 580
Milltown, NJ 08850

B.2 Biosource Software
2105 S. Franklin, Suite B
Kirksville, MO 63501
(816) 665-3678

C.1 Classroom Consortia Media, Inc.
57 Bay Street
Staten Island, NY 10301
(800) 237-1113
(800) 522-2210

C.2 Command Applied Technology
West 400 Main Street
Pullman, WA 99163-0511
(509) 334-6145

C.3 COMpress
P.O. Box 102
Wentworth, NH 03282
(603) 764-5831

C.4 Compuware
15 Center Road
Randolph, NJ 07869
(201) 366-8540

C.5 CONDUIT
The University of Iowa
Oakdale Campus
Iowa City, IA 52242
(319) 335-4100

C.6 Cooke, Dr. William
Eastern Virginia Medical School
Dept. of Pharmacology
P.O. Box 1980
Norfolk, VA 23501
(804) 446-5635

C.7 Cross Educational Software
1802 N. Trenton St.
P.O. Box 1536
Ruston, LA 71270
(318) 255-8921

D.1 Datatech Software Systems
19312 East Eldorado Drive
Aurora, CO 90013

D.2 Diversified Education Enterprises
725 Main Street
Lafayette, IN 47901
(317) 742-2690

D.3 Duane Bristow
Rt3, Box 722
Albany, KY 42602
(606) 387-5884

D.4 DYNACOMP, Inc.
1064 Gravel Road
Webster, NY 14580
(716) 671-6160
(800) 828-6772

E.1 Educational Activities, Inc.
P.O. Box 392
Freeport, NY 11520
(800) 645-3739
(516) 223-4666

E.2 Educational Materials and Equipment Co.
P.O. Box 2805
Danbury, CT 06813-2805
(203) 798-2050

E.3 EduTech, Inc.
303 Lamatine Street
Jamaica Plain, MA 02130
(617) 524-1774

F.1 Fund for Research in Alternatives to Animal Experimentation
Biberlinstr. 5
8032 Zurich
Switzerland

H.1 Health Sciences Consortium
201 Silver Cedar Court
Chapel Hill, NC 27514
(919) 942-8731

H.2 HRM Software
175 Tompkins Avenue
Pleasantville, NY 10570
(914) 769-7496
(800) 431-2050

H.3 Huntington Computer Project
State University of New York
Stonybrook, NY 11794

I.1 Indiana University School of Medicine
Department of Physiology and Biophysics
635 Barnhill Drive
Indianapolis, IN 46223

I.2 Information Systems for Medicine, Inc
P.O. Box 247
Phoenix, MD 21131
(303) 666-2672

I.3 Intellectual Software
Division of Queue, Inc
562 Boston Avenue
Bridgeport, CT 06610
(800) 232-2224

I.4 IRL Press
P.O. Box Q
McLean, VA 22101-0850
(703) 437-3334

P.O. Box 1
Eynsham, Oxford OX8 1JJ
United Kingdom

J.1 J & S Software
14 Vanderventer Avenue
Port Washington, NY 11050
(516) 944-9304

K.1 Kinko's Service Corporation
4141 State Street
Santa Barabara, CA 93110
(800) 235-6919
in CA (800) 292-6640
outside USA (800) 967-0192

L.1 Lea & Febiger
600 S. Washington Square
Philadelphia, PA 19106
(215) 922-1330

L.2 Life Science Associates
1 Fennimore Road
Bayport, NY 11705
(516) 472-2111

M.1 Medman Simulations
P.O. Box 160
Chestnut Hill, MA 02167
(617) 732-7330

M.2 MedSoft
1105 Arondale Drive
Fircrest, WA 98466
(206) 565-5068

N.1 National Resource for Computers in Life Science Education
Mail Stop RC-70
University of Washington
Seattle, WA 98195
(206) 548-6244

N.2 Neosoft, Inc.
CBS Interactive Learning
One Fawcett Place
Greenwich, CT 06836
(800) 227-2574

N.3 New Jersey Medical School
Joseph Boyle, MD
100 Bergen Street
Newark, NJ 07103
(201) 456-4464

O.1 Oakleaf Systems
P.O. Box 472
Decorah, IA 52101
(319) 382-4320

R.1 Randall, Dr. James
Department of Physiology
Myers Hall
Indiana University
Bloomington, IN 47405
(812) 335-1574

R.2 Rush Medical College
Drs. Joel Michael and Alan Rovick
Department of Physiology
1750 West Harrison Street
Chicago, IL 60612
(312) 942-6426; (312) 942-6567

S.1 Scott, Foresman and Company
1900 East Lake Ave.
Glenview, IL 60025
(312) 729-3000

S.2 Siegman, Dr. Marion J.
Department of Physiology
Jefferson Medical College
1020 Locust St.
Philadelphia, PA 19107

S.3 Simpac Educational Systems
1105 North Main St., Suite 11C
Gainesville, FL 32601
(904) 376-2049

S.4 Sliwa Enterprises, Inc.
2360-J George Washington Hwy
Yorktown, VA 23666
(804) 898-8386

T.1 Thoroughbred Educational Software
Division of Queue Inc
562 Boston Avenue
Bridegport, CT 06610
(800) 232-2224

U.1 UMKC Software Series
2411 Holmes Street
Kansas City, MO 64108-2792
(816) 276-1891

U.2 University of Texas System Cancer Center
MDAH, Box 6
6723 Bertner
Houston, TX 77030
(713) 792-2581

W.1 Walker, Dr. J.R.
University of Texas Medical Branch
Galveston, TX 77550
(409) 761-2966

W.2 Wiley Professional Software
605 Third Avenue
New York, NY 10158
(212) 850-6009

W.3 Williams & Wilkins
428 East Preston Street
Baltimore, MD 21202
(800) 638-0672

CAN YOU HELP?

Among the major goals of NRCLSE are to help life science educators identify colleagues who share a common interest in the use of the computer as an educational tool (see Annual Colleague Directory, February - April, 1988 CLSE) and to help life science educators identify appropriate software for use in their curricula.

In an attempt to achieve the latter, we routinely publish software lists (see Where's the Software). However, these lists do not offer any information regarding the applicability of programs to specific curricular needs. To provide this type of information, *we need your help*. Please take a few moments to let us know what software works for you.

For each program, tell us:

- The title, source, content area, and cost of the software;
- The hardware requirements;
- Whether the program is a tutorial (Q&A), a simulation, a combination of the two, or a utility;
- What student population uses the software at your institution;
- How you use the software; and
- What you like *best* and *least* about the software.

Mail information to NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195. ***Be sure to include your name, address, phone number, and BITnet address (if applicable).***

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NRCLSE SOFTWARE EVALUATION SUBMISSION FORM

The NRCLSE software evaluation program has been initiated (see October, 1988 CLSE) to promote development of high quality, versatile educational software in the life sciences by providing authors with feedback from critiques by life science educators and instructional designers. To ensure that software is reviewed in an appropriate fashion, it is essential that reviewers fully understand the rationale underlying the design criteria chosen by the author and the environment for which the software is intended. Please provide the following information concerning each software package to be evaluated.

Submit 3 complete copies of the software and all supporting documentation along with $25 (to cover handling, mailing, and follow-up costs) **to Software Evaluation Program, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.**

Author's name:

Author's address:

Title of software: **Content area:**

Minimum hardware requirements:

Optimal hardware configuration:

Software requirements (operating system, etc):

Student population for which software was written:

Environment for which software is primarily intended (independent study, classroom discussion, lecture enhancement, etc):

How long has this software been used by students?

Can reviewers keep the review copy of this software?

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Describe the underlying philosophy of this software. What need prompted the development of this software? Why was the specific format of the software chosen? What goals did the input/output scheme (or screen design) address? Is documentation an integral part of the package? How is it intended to be used? (Use additional pages if necessary.)

Has the software been evaluated by students?

Briefly describe the format and results of any student evaluation.

What attempts have been made to evaluate the impact of the software on student progress?

What were the results of the impact evaluation?

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should not exceed 2000 words and should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper. The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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NRCLSE

CONTENTS

CLSE 1989 COLLEAGUE DIRECTORY – PART I 33

NRCLSE QUESTIONNAIRE 39

CLSE 1989 COLLEAGUE DIRECTORY – PART I

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is updated from the 1987-88 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 39). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part II of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire on page 39, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to NRCLSE, Mail Stop RC-70, Univ. of Washington, Seattle, WA 98195 or let us know via BITNET. NRCLSE's BITNET address is MODELL@UWALOCKE.

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NATIONAL RESOURCE FOR COMPUTERS IN LIFE SCIENCE EDUCATION QUESTIONNAIRE

To be effective in our effort to promote a communication network among life science educators interested in using computers in their educational efforts, ***we need your help.*** Please take a few moments to complete the questionnaire below and return it to the following address:

Harold Modell, Ph.D.
NRCLSE
Mail Stop RC-70
University of Washington
Seattle, WA 98195

Name: ____________________

Address: ____________________

____________________ State ________ Zip ________

Phone: ____________________ BITNET: ____________________

What content areas do you teach? ____________________

What student population(s) do you serve? (Please check the appropriate categories)

_____ Undergraduate _____ Graduate _____ Nursing _____Medical

_____ Allied Health _____ Dental _____ Veterinary

_____ Other (please specify)__________________

Are you currently using the computer as an educational tool? ___Yes ___No

If yes:

How many years have you used the computer in this way? _______

What kind of equipment are you using (please check appropriate categories)

_____Apple II family _____ IBM or IBM Compatible

_____MacIntosh _____ Minicomputer (Please Specify) ________________

_____Mainframe (please specify)____________________

Have you written any software for use in your teaching efforts? ____Yes ____No

Would you be willing to help critique software for peers? ____Yes ___No

Additional comments or suggestions for NRCLSE:

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should not exceed 2000 words and should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper. The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

COURSE OF ACTION™: CAI SOFTWARE TOOL FOR MACINTOSH COURSE AUTHORS 41
R.B. Heath

KEEPING ABREAST OF THE LITERATURE 43

CLSE 1989 COLLEAGUE DIRECTORY – PART II 44

COURSE OF ACTION™: CAI SOFTWARE TOOL FOR MACINTOSH COURSE AUTHORS

R.B. Heath

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In a recent paper on selecting an authoring system[3], Mary Trainor presented 14 questions for examination of potential authoring systems to use in computer-aided education. Course of Action™ answered 12 of Dr. Trainor's questions in a very positive and progressive manner, expanding most needs beyond the basics so that even the future is planned for. This software excels at the job of author *and* student interaction within the course and between teacher and student. There is beautiful delivery of your personal custom style, with the traditional user-friendly standard interface of the Macintosh. It is the strongest program available, and other references support this.[2] Ease of creation is the strength. Delivery is constrained to single disk modules or mini-courses, although fairly large courses can be built with surprisingly small memory space. Dave Bakkum, representative of Computrends, the vendor, feels that large scale delivery will be expanded to hard disk to accommodate industrial users and large class sizes.

Course Of Action™ allows authors to be as creative as they wish, supporting almost any imaginable presentation need with an extensive toolbox of icons representing a screen or action within a

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Course of Action is a registered trademark of Authorware, Inc., Minneapolis, MN.

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screen. Two modes of operation are used: an authoring mode, working from either outside or inside the screen as it is being planned, composed, and edited, and a delivery mode which is what the student would experience in the completed course. At any point, the author can jump back and forth between modes and call up the toolbox for quick touch-up editing.

The storyboarding that adds time and effort to some programs is internally handled by Course of Action™ with pieces easily grouped on a track in the authoring mode. You have instant placement and edit control over icons for display, question and associated branching, animation, decision and branching, groups or maps of icons, and a hugh library of built-in functions and variables. Jumps can be made between Course of Action™ mini-courses and from the application to other applications such as Hypercard or Videoworks to interface with other creations. It is also possible to command videodiscs and multiple monitors.

Instructions are written for interfacing your own programming skill in any Macintosh language (Pascal and C interface files are provided) with the software to extend the interface to your particular delivery style and needs. Compiling the nuts and bolts of the scripting/programming is carried out in the background of the presentation screen, making a very clean, uncomplicated environment for authors. This non-threatening atmosphere makes it truly an applied authoring tool for busy faculty and novice beginners. The software is worth the price for that alone.

Graphics, where Macintosh shines in the first place, is the second strong point. Any text or graphic you can get on your screen can be imported into Course of Action™. Bitmapped, Paint, or PICT stored images are easy to manipulate. Once they are scanned, digitized, or otherwise created by your methods, they fit right in as objects for screen building in your course. They can be managed by all the rules of the course and can be stretched, moved, overlaid or animated as you wish. Any object from any icon display screen can be held on screen display through combinations of other displays, therefore allowing multiple layers and sprite type animations. Simulations are effected by using the many different branch decisions and default settings for questions. For instance, an object can be moved by a student as an answer to a question! If the movement is correct, and placement is accurate, branching goes to positive feedback of the author's design. If the placement is inaccurate, the object is returned to the starting point, and feedback prompts for second tries can be designed, or you can encourage more work, such as review from menus that can be built in. Reactions or answers by the student can be monitored by built-in variables and stored for author information on performance, or they can be used by the program to manage mastery levels and force branching to more difficult questions.

Bitmapped animations contained in movies can be created and imported as pieces of a display. Digitized sounds are supported with provision for importing canned files (5.5 to 22K Hz) or recording and editing your own. Future versions (v1.5, nearly complete) will support color and be able to export through file conversion programs to MS-DOS formats, so that authoring can be accomplished in the graphic user-friendly Macintosh environment with delivery in IBM-compatible systems.

Support in the manuals (yes, plural – a manual is provided for each special feature plus two large application manuals for authoring and creation of a demonstration autotutorial) is excellent. In addition, the person you usually reach on the phone is apt to be one of the original programmers who has had a broad spectrum of experience and seems to know exactly what you are trying to ask.

A tremendous advantage of this program is its flexibility and ease of editing. The company recommends that you experiment with your creative course writing by jumping right in and learning as you go. As a beginning author, I found this to be good advice and have seen my peers benefit by doing so also. The use of the Macintosh and this software as a "scratch-sheet" lends speed to editing and creativity. This is important to busy faculty who have limited time to be authors themselves. Course of Action™ allows easy, enjoyable course creation for these individuals, and it helps save time for faculty who have work study students, where ideas and small amounts of direction can be seeded to create very valid courses in a team approach.

Our main use of CAI is to review mini-subjects as preparation for laboratory experiences, surgical procedures, clinical problems, and case management philosophy. I work in a busy hospital with colleagues of varying degrees of computer knowledge, experience, ease, and fear! The amount of enthusiasm that has been generated is quite clear. When I demonstrate any courses created with Course of Action™, there is universal response. The response is, "Gee, that would work just right for this or that idea of mine!" – quickly followed by the question, "when can we start?" The first problem is getting our hands on enough Macintosh machines for authoring stations and delivery carrels. The second problem is getting enough time to do all the things that pop into everyone's head. Major overhaul jobs loom in the future for all the notes and all the autotutorial units that are sitting around with minimal use. To be able to attack the hugh information base in today's medical curriculum and build in the strong interactive feedback capability of the CAI philosophy is exciting to faculty and students alike.

Student acceptance is high, and feedback is complementary. Most want to help edit and create the next revision with their own ideas for the courses by finding new graphics and blending in the latest literature that they may have found in the library. The concept of cooperative learning that is being touted in education circles[1] is easy to facilitate with the course building here. One graduate, waiting for a residency to

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begin, is volunteering time to program a new wrinkle for his pet subject.

Our audience includes junior, senior, intern, and resident DVM professional curriculum students with multiple backgrounds like medical students in general. The overall enthusiastic acceptance and eager "how can I help" attitude speaks directly for Course of Action™ as our choice to advance CAI in our veterinary medicine curriculum.

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KEEPING ABREAST OF THE LITERATURE

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CLSE 1989 COLLEAGUE DIRECTORY – PART II

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1989 directory published last month. It is updated from the 1987-88 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see May, 1989, page 39). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part III of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire in the May issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should not exceed 2000 words and should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, Mail Stop RC-70, University of Washington, Seattle, WA 98195.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper. The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

MICROCOMPUTER WORKSTATIONS FOR HUMAN PHYSIOLOGY LABORATORIES 49
Jennifer L. Breckler

CLSE 1989 COLLEAGUE DIRECTORY – PART III 51

MICROCOMPUTER WORKSTATIONS FOR HUMAN PHYSIOLOGY LABORATORIES

Jennifer L. Breckler
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Traditionally, human physiology laboratory experiments have aimed at observing living tissues and understanding their function. However, the physiology curricular needs are changing rapidly. Efforts are currently underway at many undergraduate institutions to reduce or eliminate the routine use of animal experiments in physiology lab courses and reduce or eliminate human tissue experiments that involve potential contact with foreign body fluids (ie, blood) to avoid disease transmission.

One way to approach the problem of replacing or augmenting traditional physiology experiments is through the introduction of computer software. The most useful method of introducing or adding computers to the physiology laboratory is to create microcomputer workstations. Optimally, there should be one workstation for each pair of students, but as few as two workstations can service a class of 20 students.

WORKSTATION GUIDELINES

A number of guidelines should be kept in mind when designing workstations for student laboratories. These include the following.

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Workstation Mobility

A cart can be built or purchased to house the workstation's microcomputer, monitor, moveable keyboard, and printer. The cart allows the versatility to place the unit at different lab benches, at physiological measuring devices for data acquisition, or in a different room for after-class work or study.

Vertical Hardware

A vertical arrangement of roll-out shelving with each unit on top of the next is best. This keeps the unit compact and discourages its use as a desk or workbench. Since most physiology labs contain many built-in lab benches and "wet" areas, the vertical arrangement keeps the workstation dry and away from experimental areas.

High Speed Printers

Purchase the fastest dot-matrix printer that you can afford. The reason for a fast printer is that during a particular experiment involving data acquisition, large amounts of data and/or tables are often obtained. The limitations of the 2 or 3 hour lab period make it essential to print out data quickly. A "letter quality" (24-pin) dot-matrix printer is not a necessity, although often these printers have a very fast draft quality mode that can be used for the data printout. These make excellent word processors after class.

Multiple Usage

The microcomputer workstation will become one of the most useful laboratory equipment items because of its versatility. Because most currently available physiology software is programed for IBM and compatible machines, we prefer these microcomputers. Certain programs are also available for the Apple //e or Macintosh.

Workstation Security

Unfortunately, the problem of computer theft exists on many campuses. Safety locks on the microcomputer base can save needless aggravation because they act as a deterrent. Locks are especially recommended in a room with constant access in a large institution.

WORKSTATION APPLICATIONS

The choices for how to use the microcomputer workstation vary widely, but one must first take into account whether the equipment is to serve primarily biology majors or non-majors. We have found that these two groups have different needs, primarily due to differences in prerequisite math and science backgrounds. Demonstrations or instructor run simulations with predictable results can be more effective for non-majors. Biology majors might benefit from being able to manipulate data directly, however, because they should appreciate the subtleties of data collection and analysis.

In general, the human physiology laboratory microcomputer workstation can be used for data acquisition, data analysis, or physiological simulation programs. There are several excellent data acquisition programs from Intellitool, Inc. (Cardiocomp, Spirocomp, Flexicomp) that come with small equipment items that can be set up easily. All three of these programs recently became available for the IBM-PC. For example, in Cardiocomp, real-time electrocardiograms can be observed, stored, and then analyzed extensively, just like in the modern clinical setting. Normally, EKG analysis such as determining time intervals or vectors takes hours for students to perform at home. Computer analysis is quicker and more accurate and allows time for in-class discussions of the data in the same lab period. Students can each have their own data disk to take to the library or to after-hours microcomputer facilities.

Many outstanding simulation programs are available in almost every area of physiology, and these can be run by the instructor or by students at their individual workstations. After new software has been introduced, it is important to get feedback from both the lab instructors and the students on the value of the time spent in using the software during the lab. A simple questionnaire given out at the end of the lab period can address issues such as ease of use, enjoyment of the exercise, and adequacy of instructor supervision. In time, the computer can become a valuable friend to the physiology lab student and help achieve the goal of learning the subject in the best way possible.

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CLSE 1989 COLLEAGUE DIRECTORY – PART III

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1989 directory published last month. It is updated from the 1987-88 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see May, 1989, page 39). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire in the May issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

A COMPARISON OF THREE GRAPHICALLY ORIENTED SIMULATION ENVIRONMENTS FOR THE MACINTOSH 57
Jeff E. Mandel

A COMPARISON OF THREE GRAPHICALLY ORIENTED SIMULATION ENVIRONMENTS FOR THE MACINTOSH

Jeff E. Mandel
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Mathematical models of physiologic and pharmacologic phenomena are of increasing interest for academicians. While complete packages incorporating mathematical models have become available, there is still benefit to be derived from constructing simple models "from scratch." Such development efforts can be accelerated by programming environments that manage routine tasks, such as maintaining the user interface and performing the numerical integration. This review compares three graphically-oriented simulation environments for the Apple Macintosh, examining the facilities they offer the user and the shortcomings they possess, so that the reader may have a realistic view of what to expect when purchasing one of these packages. The packages discussed are STELLA 2.0 (High Performance Systems, Dartmouth, NH), Extend 1.05 (Imagine That!, San Jose, CA), and LabView 1.2 (National Instruments, Austin, TX). Because individual reviews of these packages are available, general comments on the capabilities of the programs, the attractiveness of the manuals, or the knowledgeability of the customer support lines will be omitted. Experiences in implementing a simple model in each of these packages will be the focus of this article. In each case, this model was my first major programming effort in each of the packages, and thus I was able to assess the learning curve for the three packages. It should be noted that my background is in systems science engineering, and I have a long involvement in and experience with physiological modeling. Experiences of several

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senior undergraduate biomedical engineering students who participated in model development in independent study projects under my supervision will also be related.

The system selected for modeling is the cardiovascular system. A numerically integrated time-varying elastance model with a single atrium and ventricle and a two compartment windkessel was utilized. Its electrical analog is presented in Figure 1. This model is a system for which parameters are readily available and performance well known, and it presents problems in implementation that can be expected to test the flexibility of the programming environment. As nearly as possible, the model was implemented with an identical structure in each package to produce graphical output of the ventricular pressure-volume loop. The simulation packages were evaluated for the ease of implementation, the need to utilize programming tricks to circumvent the limitations of the programming repertoire, the ease of debugging, and the performance of the finished product. Because the intent of this article is to compare three simulation packages, only a few comments on the implementation of the model are included. The model utilizes the following three basic principles of physics.

- The pressure in a compartment is equal to active volume times the elastance.
- The flow from one compartment to the next is equal to the pressure differential between them divided by the resistance separating the compartments.
- The volume of the compartment is equal to the integral of the sum of inflow and outflow.

The model utilizes constant arterial and venous elastances and nonlinear, time-varying atrial and ventricular elastances. In addition, time-varying unstressed volumes are employed in the atrium and ventricle. The time-varying functions were driven by sinusoids. Numerical integration of the flow was achieved by Euler's method. Step size must be sufficiently small to assure that the volume change at each step is small with respect to the active volume of the compartment; a value of 0.001 seconds was used. A description of this model has been presented elsewhere.[1]

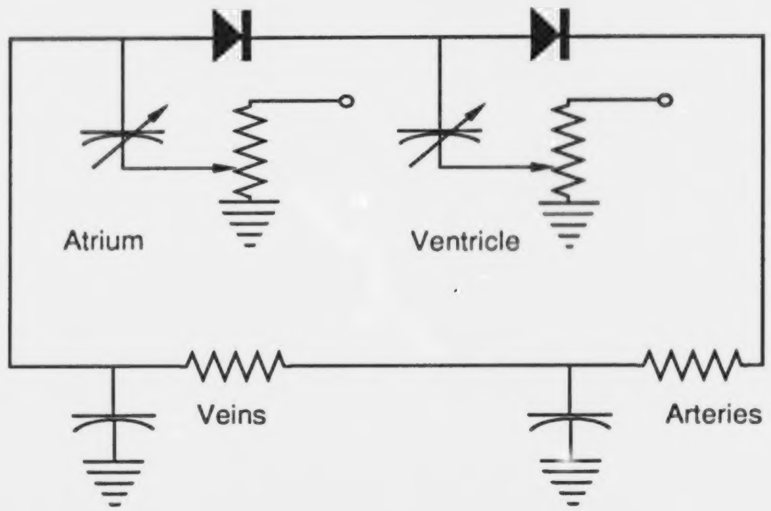

FIGURE 1. Electrical analog of the cardiovascular system model implemented in STELLA, Extend, and LabView.

THE PROGRAMMING METAPHOR

STELLA

Of the three packages, STELLA has the most rigid programming metaphor, which is based on the Dynamo language developed by Forrester. STELLA deals with flows from one compartment to another. Flows are controlled by information generally derived from the levels found in the compartments. A model is built incrementally, first creating the compartments, next connecting them via flows, and finally building the information links that govern the flows. Thus, programming in STELLA is top-down, proceeding from the most general view of the system to the details. While STELLA programs are not necessarily self explanatory, it is easy to implement programs in which the core structure is readily discernable. STELLA handles flow control within the simulation implicitly, making decisions on which order functions are evaluated without explicit instructions from the user. This is advantageous to the neophyte as it eliminates many common errors, but it complicates the only way to have a variable that is calculated recursively, such as a loop timer, is to create another compartment. In the cardiovascular model, a variable is used to track time within the individual heart beat. This variable cycles from zero to the cardiac interval and permits easy synchronization of events of the cardiac cycle. To implement this, an additional compartment was required with a constant inflow and a periodic negative impulse to generate the sawtooth. Implementation of this structure was the single most difficult aspect of the modeling effort. Thus, while the idea of strong typing is good, an additional data type that would permit implementation of such global variables would be a significant enhancement.

STELLA's programming metaphor is ideal for most problems found in pharmacokinetics. For more involved physiologic simulations, it possesses limitations that require the user to circumvent the normal structure of a STELLA model. While this does not create a problem, it suggests that STELLA is not the ideal tool for such simulations.

Extend

Extend is the most procedurally oriented of the three packages. Extend utilizes a programming language called ModL, which is most like C in syntax, but FORTRAN and BASIC programmers will quickly catch on to the syntax (although I still forget to end each statement with a semicolon). ModL is object-oriented – each object is a block that contains a series of handlers. Handlers execute in response to messages, much as in HyperCard. Unlike HyperCard, ModL limits the use of user-defined messages and does not permit a handler to break the chain of message passing. This is not a major shortcoming for simple projects, but it would be of use for advanced ones and is said to be a feature of the next major revision of Extend. Extend defines messages that apply to all blocks during the simulation run, and messages that apply only to individual blocks during the editing phase. During the simulation run, messages denote simulation initialization, each integration interval, and the end of the simulation run. Extend passes these messages to blocks based on their left-to-right order on the screen; the user has the option of using the data from the current integration interval from blocks already evaluated or using the values from the previous integration interval. This is generally of little concern, unless one is simulating a sampled data control system. Messages are also passed to the individual block when it is created, when its dialog box is opened or closed, and when a button in the dialog is clicked. Messages are passed to their handlers – one or more lines of ModL script – that can perform any operations needed to respond to the message. Because the programmer can gain control during initialization and at the end of the simulation, it was easy to store the appropriate initial conditions for future runs. While Extend does not enforce a top-down programming approach, it does not preclude it either. Once familiar with the system, the practice of first defining the inputs and outputs of the block, then working backwards from the most general to the most specific equations was the most productive.

Extend is weakly typed; all variables are declared as one of three data types – real, integer, and string. A variable may only be used in a way appropriate to its type (eg, you cannot obtain the natural logarithm of a string). If you decide, however, that you want to increment the blood volume in one compartment by a flow and decrement the blood volume in the adjoining compartment by something other than a flow, Extend will dutifully permit you to ignore conservation of mass. Thus, the programmer must decide on a convention that precludes such errors; I chose to propagate outflow to the downstream compartment and backpressure to the upstream compartment. Extend permits a variable to be local to the handler or global to the block. A global variable retains its value from one call to the block to the next while a local variable loses its value on completion of the handler in which it is declared. Thus, a value that need only be calculated once can be stored in a global variable and calculated on initialization of the simulation.

Information is passed from one block to another by named signals. Named signals may be used as if they were global variables within the ModL script and appear as connectors available for wiring from one block to another. Extend also provides ten variables (GLOBAL0–GLOBAL9) that are global to all blocks. Global variables are quite useful for passing information to multiple blocks without having to increase the complexity of wiring the blocks together. Another useful feature is that any variable can be declared to be an array and passed through a named signal or one of the 10 GLOBALs. This permitted passing the intrabeat time around behind the scenes, thereby simplifying the connection of blocks required to build a model. The ability to devise modular components is arguably one of Extend's best features, as it permits the modeler to assemble a library of cardiovascular components that can be wired together by students to perform a variety of experiments.

LabView

LabView is the most graphically oriented of these three languages; indeed, it is much like programming with operational amplifiers and logic gates. All information is moved through wires, which may have multiple destinations but only one source. LabView has a long list of built-in functions that may be used to operate on signals. Several control structures are also available. LabView deals in objects called *virtual instruments* (VI), which consist of a front panel and a diagram. A diagram may contain (at least in theory) an arbitrarily complex jumble of wires, functions, and subVIs. The front panel is used for connection to the rest of the world; only variables present in the front panel may be wired to the VI's connector panel, making them available to superordinate VIs. Connectors may be used for input or output but not both.

LabView is weakly typed; variables may be real, boolean, or text. LabView also permits variables of a single type to be combined into arrays and front panel variables of arbitrary types to be combined with bundlers.

LabView provides a mechanism for preserving the value of a variable between calls to a subVI; the shift register. Shift registers may be loaded with an initial value. If the initial value is loaded into the shift register within a subVI, it is loaded on every call to that subVI. If the shift register is not initialized, it will contain the value it contained on the last call to the subVI. However, on the first call to the subVI, it will contain garbage. It is therefore necessary to employ some form of logic to ensure that the shift register is loaded with an appropriate value before it is used. Thus, when shift registers are used for compartment volumes, one of two strategies must be employed. In the first, the shift registers should be in the outermost loop of the simulation, with the compartment volumes passed into and out of the compartmental subVIs and the shift register initialized normally. In the second, the subVI contains a loop structure that is only there to permit a shift register to exist. Within this loop, a logical IF structure tests the value of a variable, which is true for model initialization and false thereafter. If the initialization flag is true, we place the initial volume into the output of the shift register, otherwise, we execute normally. I found it somewhat disheartening to have to go to such lengths to maintain my compartment volumes, and I found this to be the most frequent cause for failure of student programs to function.

Another shortcoming of LabView is support for numerical integration. Since I had to maintain my own compartment volumes, I found it easier to implement an Euler integration myself than to use LabView's, which is really only a tool for integrating the area under a waveform stored in an array. The sequencing of calculation of compartments cannot be achieved implicitly by LabView, since elements of the cardiovascular model form a loop. It is, therefore, necessary to wire the variables for flow and pressure explicitly from one subVI to the next through a sequencing structure. Thus, while it is possible to create virtual instruments that contain all of the calculations for the individual compartments of the cardiovascular loop, the interconnection of these elements is complex and requires a thorough understanding of the flow of information in the entire model.

LabView is certainly an interesting environment. I found the programming metaphor was poorly suited to physiological modeling, perhaps no better than FORTRAN. While I have slowly (and I emphasize slowly) come to understand that it is possible to set up LabView subVIs that possess the capabilities of an Extend block, the responsibility for this rests on the programmer.

PROGRAM IMPLEMENTATION

STELLA

STELLA provides a palette of tools much like MacPaint, and program elements are created by selecting a tool and clicking on the page. Elements are connected by wires. Once connected, the element may be opened by double clicking, and the input signals may be combined via equations to form an output. STELLA indicates elements that have not been properly defined with question marks. Until all elements are properly defined, the model cannot be executed. Elements, and even entire sections of the model, can be selected and moved, duplicated, or deleted. Wires follow arcs from origin to destination; the radius can be controlled by dragging the origin point around the element of origin. While this works, a consequence is that a significant proportion of the time spent on a STELLA program is spent trying to fit everything neatly on the page. The ghosting tool is useful for producing neat diagrams. This permits a variable to have a copy located in another part of the diagram, thereby reducing the number of long wiring paths. STELLA is "well behaved." Tools performed as expected, and it was rarely necessary to resort to the manual. Implementation of the basic model in STELLA was rapid, requiring only about four hours. The STELLA model is shown in Figure 2.

Extend

Extend programming consists of two modes – implementation of blocks and wiring of blocks. A new block is created by a menu command that creates a window with several resizable regions and a dialog box. The dialog box is customized to permit user input to the that block; as new dialog items are added, they become available for use in the ModL script. The window contains an area for designing the block's icon, an area that lists the signals available for use in the script, an area for entering help text, and an area for ModL scripting. Icons may be of arbitrary size and complexity (linguistic purists might argue that this excludes them from being icons). Connectors are attached to the icon. A minor inconvenience is that connectors must be labeled with the free text tool. It would be preferable to display the connector's name as its label and have changes in the connector's name propagated through the entire block. Initially, the ModL script contains four handlers (Simulate, Checkdata, Initsim, and Help) in skeleton form. ModL scripting is much like HyperCard scripting, except it does not automatically indent. The editor is usable and contains some useful search/replace features. It is not in a league with MPW or QUED/M. Once the blocks are implemented, they

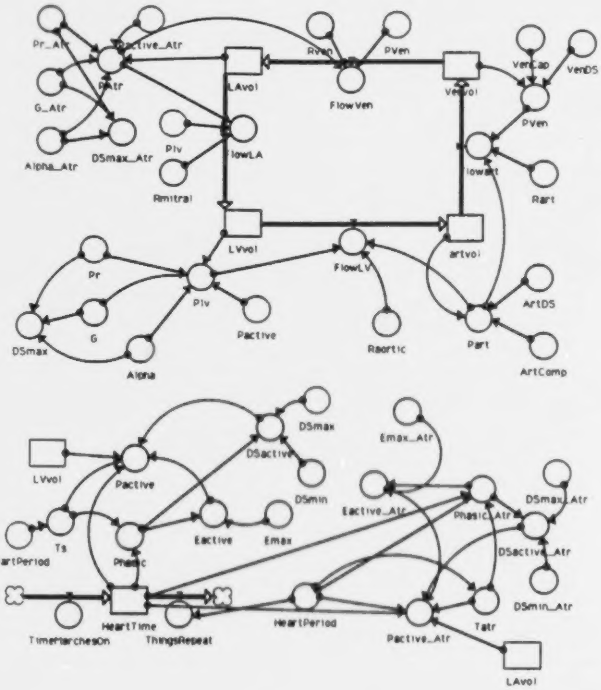

FIGURE 2. Representation of the model shown in Figure 1 as implemented in STELLA.

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are wired together to form a simulation.

Most tools performed as expected, except the free text tool, which lacks the ability to edit existing labels. Implementation of the basic model was also relatively rapid, requiring the better part of one day. The Extend model is illustrated in Figure 3.

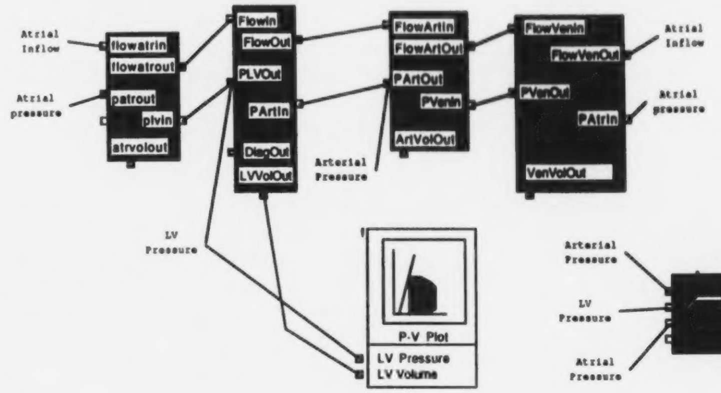

FIGURE 3. Representation of model shown in Figure 1 as implemented in Extend.

LabView

LabView programming involves a population of two windows – the front panel and the structure. All objects are selected, as icons, from dialog boxes accessed from menu selections. Objects can be copied, but only one at a time and through a mechanism not utilizing the clipboard. All elements of an equation, including constants, must be represented by these icons (there is a way to represent a single equation with a single icon, but it often increased the complexity of the model). Elements are connected by wires. Once wired, objects can only be moved by cutting all wires and moving each item individually. While in theory, wires can be arbitrarily close, in practice, close wires had a nasty habit of joining the wrong object. Due to the need either to pass compartment volumes up to higher levels or jacket compartmental calculations within a loop and logical IF, wiring often became so dense and circuitous that it was impossible to detect incorrect wiring. Thus, most of my VIs had to be implemented multiple times, cutting all wires and rearranging objects to improve the wiring runs. Special attributes of objects are set by clicking in special locations on the icon. These points would often become inaccessible as icons were densely packed. It was ultimately necessary to spend time in a lab where I could use a 19 inch monitor to see the entire structure. As the model became more complex, it took progressively longer and longer to save to disk. I had been admonished by friends to save my work frequently, since LabView programs that acquire too many elements *can not be saved to disk*. In this event, the only recourse is cut elements out of the model and create a subVI that contains these elements. Mercifully, this fault was never encountered. Nonetheless, it took two weeks of intermittent work to implement the basic model, not including the two day introduction to LabView provided by an experienced user. Working in LabView for more than two hours at a stretch proved fatiguing. In short, LabView is a tedious programming environment. The main diagram of the LabView model is illustrated in Figure 4.

TOOLS FOR THE USER INTERFACE

STELLA

STELLA provides the ability to plot as many as four variables simultaneously against time. Alternatively, one variable can be plotted against another. Multiple plots can be defined on the graph pad, but only one can be viewed at a time. Data can also be output in tabular form. All output is performed as the model executes. User input to a STELLA model requires the user to open the appropriate objects and change their values. Short of arranging these all in one area of the page, there is no easy way to let the user know which parameters to alter (I guess that's why people write lab manuals). The lack of a mechanism to organize user input is, in my view, STELLA's greatest weakness. This is said to be addressed in a new release that permits a HyperCard front end to a STELLA simulation.

Extend

Extend provides functions that can be used to produce graphic output, either as up to four variables against time, or as two sets of x-y plots. Although only four variables can be placed on a single plot, multiple plotting windows can be used simultaneously. These functions can be used within the scripts of a single compartment, or they can be implemented in separate blocks. Learning to use the plotting functions was the most time consuming aspect of the work with Extend. While the plotting functions provided many useful features, some desirable features were missing. The ability to mark a spot on the plot to illustrate a point, or put more curves on a single x-y plot are examples. As in STELLA, output to plots occurs as the model executes. User input to an Extend model is through the dialog boxes implemented for each block. Unlike STELLA, it is possible to decorate an Extend block or dialog box with helpful instructions to the user as well as display help text for any block via its help button.

LabView

LabView provides several ways of viewing data. Any single variable can be connected to the front panel of a VI as an indicator and displayed as a number, a meter, or a scrolling display. Alternatively, a series of values of a variable can be accumulated into an array and plotted against another array. This is fine, except that the only way to add a new point to a plot is to redraw the

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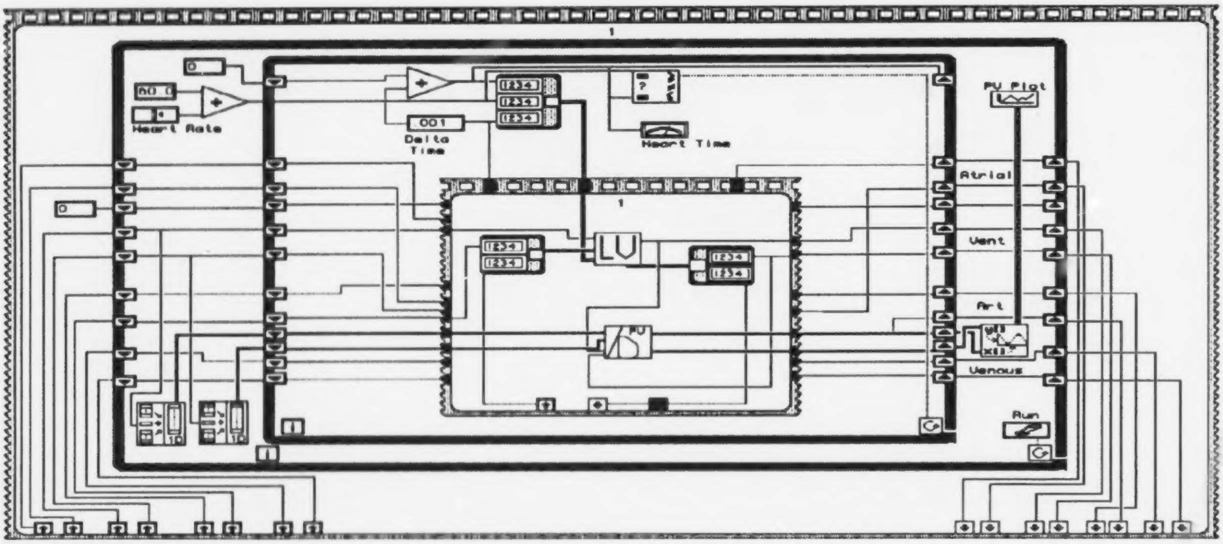

FIGURE 4. Representation of model shown in Figure 1 as implemented in LabView.

entire plot, which is visually unappealing and computationally slow. Input to LabView models is through the controls on the front panel, which can be editable text, switches, or various devices resembling knobs and slider switches. It is possible to place helpful text on a LabView diagram or front panel, however, it is often hard to find room. A significant difference between LabView and STELLA or Extend is that front panel values can generally be modified during model execution, and it is not necessary that a finite run time be specified when the model run is initiated. This could permit the development of a model in which the student was required to tweak parameters to get the ventricular pressure volume loop to match a specified loop. However, LabView would need to be about a thousandfold faster to make this practical.

DEBUGGING

STELLA

I was surprised to find that the STELLA model required debugging since the structure and parameters were easily verified to be correct. The problem seemed to lie with the structure implemented to generate the sawtooth function of time within the heart beat. By delaying the start of the function by two integration intervals, this problem was overcome. I can only assume that this was a result of the way that STELLA handles the internal states of integrators. Total debugging time was thus relatively brief, and adequate tools existed to examine any value within the model closely without altering the model structure. The model provided results comparable to the previously implemented FORTRAN model.

Extend

The Extend model required debugging due to an incomplete understanding of how best to use named signals and globals. Once this confusion was resolved, it was possible to get this model working relatively quickly. Extend provides the capability to wire any named signal to an output device. Variables can also be output as text in alert boxes. This model also provided results comparable to the FORTRAN model.

LabView

The LabView model was the most difficult to debug. Because the structure could not be verified by inspection, it was necessary to debug the individual subVIs in "test bench" VIs. This took two days, and, even then, the LabView model provides different results from the other models. Debugging invariably requires modification of the wiring paths of the program to connect output devices to signals in question. Since the simulation environment must be created explicitly from the individual compartments, it is often difficult to trace problems in the simulation environment without altering the structure significantly.

MODEL PERFORMANCE

The STELLA and Extend models ran at nearly equivalent speeds – about 35 real seconds per second of simulated time on a Mac IIx. In contrast, the LabView model required about 130 seconds per second of simulated time. For comparison, the previously described FORTRAN model runs at about 1.2 real seconds per second of simulated time on a DEC VAX 11/780 (a somewhat slower computer than the Mac IIx). I was surprised that STELLA, an interpreted language, was as fast as Extend, which is compiled. It is possible that the Extend model's performance could be improved with some more effort. A variable step-size integration scheme can be implemented in Extend which could yield as much as a

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doubling in speed. Furthermore, Macintosh driver routines can be accessed from within Extend. This could permit a time-intensive routine to be written in a language such as FORTRAN and even off-loaded to a coprocessor or network compute server. Thus, while it is hard to recommend Extend over STELLA for execution speed for simple projects, it may have advan–tages for a major project. National Instruments is said to be readying a compiled version of LabView that will be far faster than their current version. If so, it might be worth reviewing again.

EXPERIENCE WITH STUDENTS

STELLA

Only one student used STELLA for a project in simulation, and that was a pharmacokinetic model of uptake and distribution of a volatile anesthetic agent. Nonetheless, for such a model, the amount of supervision necessary for productive work was relatively minimal. As uptake and distribution models are STELLA's strongest suit, this is not surprising.

Extend

Experience with two students working in Extend indicates that once a student grasps the concept of Extend programming, the rest is easy. One student was able to further develop the basic cardiovascular model, and another implemented a neural network adaptive reasoning system in Extend.

LabView

Experience with four students working with LabView was disappointing. Despite considerable effort, one project involving simulation of female reproductive physiology was undebuggable, and another involving simulation of renal filtration never completely functioned. Two other projects that produced physiologic waveforms from lookup table were successful, but this hardly qualifies as simulation. The students never became comfortable with LabView programming in general and found particular difficulty with the use of shift registers.

CONCLUSIONS

Simulation is a form of programming with certain requirements that are common to almost all problems. However, some simulations have features that require the ability to "break the rules." In general, it is rarely the actual equations of a model that pose the barrier to implementation of the simulation; it is the maintenance of the simulation environment and the user interface that require the most understanding and effort. Thus, it is desirable to employ a simulation shell that reduces the amount of work required to implement a useful simulation. Certainly, LabView provides tools for the user interface but does nothing in organizing the numerical integration environment. While this can be done in LabView, it is difficult, and it could easily consume several months in the learning curve. STELLA, on the other hand, handles the simulation environment from cradle to grave, and while it is possible to write a STELLA model that does not work, it is generally debuggable by inspection. Extend provides a reasonable assortment of simulation tools and permits a considerable degree of freedom to program efficiently those nonstandard features required for this cardiovascular model. Thus, for quick prototyping work, or for pharmacokinetic modeling, STELLA is recommended. For more involved modeling projects, particularly those that will require operation by neophyte users, I would recommend Extend. It is hard to recommend the current version of LabView for physiologic simulation.

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1. Martin, JF, AM Schneider, JE Mandel, RJ Prutow, and NT Smith: A New Cardiovascular Model for Real-time Applications. Transactions of the Society for Computer Simulation 3(1):31-66, 1986.

Readers interested in examining the models described in this article may obtain the source code from the author by sending a disk and stamped, self-addressed envelope to:

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

HYPERTEXT OPTIONS FOR THE EDUCATIONAL SOFTWARE DEVELOPER 65
Jeff Frkonja

HYPERTEXT OPTIONS FOR THE EDUCATIONAL SOFTWARE DEVELOPER

Jeff Frkonja
Health Science Center for Educational Resources, University of Washington, Seattle, Washington

This article discusses the features and foibles of three of the popular Hypertext environments available to today's developers: Hypercard, Guide, and Linkway. If you don't think of yourself as a serious programmer, please don't let the term, developer, scare you away from reading the article. The three packages in question were designed so that anyone from student to professional programmer can use them to develop their own custom applications.

This is not a review in the sense that the packages, running as they do under different operating system software, cannot be said to be competitors. The intent is simply to provide information on the tools that are available and what they can and cannot do for you.

OPERATING ENVIRONMENTS

Hypercard, a Macintosh application, runs under the Macintosh system software. Guide for the IBM-PC-compat-

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ible world (there is also a Macintosh version, but it is not covered in this article) requires Microsoft Windows - 286 or Windows -386, versions 2.03 or later, running under DOS. Linkway runs under MS-DOS, but it does not require Windows. Still, they all attempt to create a mouse-activated, graphically displayed hypertext environment. As to storage requirements, Linkway squeezes all of its program code into an incredible seventy or eighty kilobytes (font files, etc, add more size, naturally) while Hypercard tips the scales at nearly 400k. Guide falls in between the two. Hypercard runs on a Macintosh Plus, SE, II, IIx, or IIcx and requires at least one megabyte of memory and a hard disk; Guide requires a PC-AT or PS/2 or better with at least 640k of memory and hard disk; Linkway requires a PC with at least 384k of memory and a single 360k floppy disk drive. All three programs require the use of a mouse.

In some cases, the operating system software provides features that are usable by the hypertext programs in question but are not actually provided in the program's own code (eg, the Macintosh Clipboard). It should be remembered for purposes of comparison that these features are available to most applications that would run under the same system.

BASIS OF THE REVIEW

The comparisons made herein are based on attempts to use the three products to develop educational applications that integrate bodies of text, graphical images, and calls to external devices such as videodisc players. Imagine, for example, a tutorial that uses photographs stored on a videodisc, in addition to text and graphics, to illustrate disorders of the human eye.

This leads us to the following specific areas of evaluation.

- Features (basic format, buttons, fields, navigational aids, etc.)
- Application layout and design.
- Importation of external data, including text (story), "raw" data, and graphical images.
- Creation of text, graphics, or data from within the development environment.
- Implementing calls to external tools or devices (subroutines, machine code, etc. *Not* data import).
- Making changes to layout, design, or any of the "content" data (text, data, or graphic) well into the development process ("second thoughts"—this evaluation area tests the flexibility of the environment).
- Customization/Enhancement: Does the environment have a "scripting" or programming language so that its applications can be customized and so that the developer can make custom tools?

FEATURES

What do they give you to start with? Applications from the three packages will appear to be very similar to the casual user because many of the features provided are virtually identical.

Basics

All three packages provide hypertext capabilities, allowing the developer to assemble a stack (Hypercard), folder (Linkway), or guideline (Guide) with internal links that allow the user to navigate quickly through an integrated text/graphics application. Hypercard and Linkway accomplish this through a stack analogy (even though Linkway calls its stacks folders and its cards pages). Discrete applications (stacks) consist of entities called cards that are physically the size of the display screen. The virtual size of these cards is enlarged through the use of card elements like scrolling fields and hidden elements in Hypercard (any field, button, or other object in Hypercard can be hidden) or pop-up buttons or pictures in Linkway. Linkway limits the size a single folder to 250k, while a single Hypercard stack is limited only by the amount of disk storage you can provide. Linkway also has some limitations on the size of each individual page (8k) and the size of any of its command scripts (3k). It is true that these limitations allow Linkway to run on such low-level machines as the IBM PC-jr., but such constraints make for more work and more complication. If you are dealing with large amounts of data in Linkway you will have to create a large array of pages, scripts, and folders split into many disk files. Still, Linkway, like Hypercard, allows for links between separate folders (stacks) so that your applications can be as large as you wish.

An appropriate physical analogy for Guide applications files is a scroll containing text and graphics. The scroll, called a guideline, can be of theoretically infinite length (depending on disk storage limitations). You view the guideline one "window-full" at a time through the windowing functions of Microsoft Windows, and therefore, all Windows features are accessible at all times. These features include window sizing options, the ability to position the window anywhere on the display, and a scroll bar that can be used to adjust your vertical position in the guideline. The margins of the guideline are automatically resized to fit the width of the window you have opened which destroys any development efforts to present a standardized screen appearance. The automatic margin resizing cannot be disabled. The basic Windows interface also provides easy access to the DOS Executive Window. This is an edged tool that cuts two ways. For experienced users, it can be a plus, but for the uninitiated, it often can spell disaster.

All three products include search capabilities. They can search quickly through an entire stack, folder, or guideline and take you to the text for which you seek. All of them can perform case-insensitive, containing-type searches (upper- and lower- case letters are treated identically, text will be found if it is contained in a longer word). All have a "find next" option to let you save time by avoiding retyping, but none of them can provide you at one time with a report of the locations of all occurrences of the search string, at least not as they come "out of the box." Guide is helpful here in that it provides a global replace option with its find command. You may choose to replace all occurrences of a string, one occurrence, or to be prompted for verification of each replacement.

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Links

All three packages provide linking tools to allow navigation within a single file and between files. In Guide, all of these links must be specifically defined by the developer. In other words, you must explicitly build in your links between preexisting origins and destinations. This is only partially true for Hypercard, which is able to modify its own objects through its internal programming language, Hypertalk. While you must have both an existing source and destination card to establish a Hypercard link, you can program buttons or other objects to create these cards automatically and then link them, so that an end user or someone unfamiliar with your stack can add information just by pressing a button. Linkway falls somewhere between these two scenarios. You can create new pages automatically and link them, but you will have to do more programming work to track what is being done and to achieve effects that Hypercard provides in single commands.

Buttons

All three packages make extensive use of various types of display objects they call buttons. In general, a button is an area of the display in which a user may click (place the cursor and depress the mouse button) to cause a certain action to happen. Links are invariably activated by using such buttons. In Hypercard, buttons perform functions such as taking you to other cards, revealing hidden objects (which can be any button or field), and modifying or executing any other object. Essentially, any action that can be programmed in Hypertalk or performed from the command menu can be invoked from a Hypercard button. Now that is flexibility. You must be fluent in Hypertalk, however, to address all the possibilities, because all buttons execute a Hypertalk script to perform their actions. Buttons may be invisible, so that they can overlay any part of the card you desire, they may take a variety of predefined shapes (including the standard Macintosh system buttons), and they may be represented by icons.

In Linkway, buttons may also be invisible or represented by icons. They perform similar functions to Hypercard buttons but in a more limited fashion. Each Linkway button has one specific function. One type executes a command script written in Linkway's scripting language, one type pops up a scrolling text window, one pops up a graphic, and others provide navigational links. Linkway buttons can be hidden and revealed by the subterfuge of pasting a pop-up graphic over them — there is no explicit hiding command for objects as in Hypercard. They can also execute other buttons, although they cannot execute command menu options unless those options have a similar function explicitly provided in Linkway's scripting language. It is noteworthy that Linkway's text pop-up button is its only text container with a scrolling capability like that of Hypercard's scrolling fields. The text pop-up, however, is limited to a total on-screen area of approximately 400 characters (number of rows times number of columns occupied by the pop-up box).

Linkway also has a rather interesting button that pops up a primitive text editor that can display a single external text file. This gives the developer a way to bypass Linkway's page size restrictions, because the editor can scroll through the information it presents. Linkway's editor may be set to allow or inhibit changes to the file. This editor, however, always occupies the entire screen, blocking out the rest of your page while it is active. The editor does not automatically display any help information, although such material is available by pressing the F1 key. These factors make its value in presenting information to the less experienced user rather dubious.

Guide buttons are more similar in action to those of Linkway than to Hypercard's. Each Guide button performs one function. A link type takes you to a specific location in the current Guideline or pops up a window displaying another Guideline, if the link points to a location in a different file. Another type of button executes commands, which, at this writing, are limited to addressing the serial ports or launching other Windows applications. A very powerful type of button is the replacement button, which, when clicked on, is replaced with another segment of guideline that can be of almost infinite length. Using the replacement button, you can nest an entire Guideline within the buttons of another.

The replacement button illustrates a striking difference between Guide and the other two packages. In Hypercard and Linkway the various on-screen objects are discreet entities that may or may not have callable functions and may contain text. In Guide all of the objects on screen are text (Guide, it should be noted, inserts its graphics into the text stream and essentially treats them as a large character that can be moved by tabbing or spacing). Guide buttons are defined by selecting a block of text and specifying what type of button that text is to become. Destinations or replacements are chosen the same way. The style of the button text automatically changes to indicate the type of button or link, a nice feature that can be difficult to implement in Hypercard.

The advantage of Guide's system is that if you make large insertions or deletions of material, all your buttons flow along with the text that represents them. In Hypercard, if you overlay a word in a field with an invisible button then add text to or resize the field, you will need to relocate your button manually. The disadvantage of the Guide system is that on-screen locations of objects and buttons (remember, graphics are part of the text stream) is fluid and depends on page formatting variables, such as window width and height, which may change from session to session. You have no guarantee that your files will be displayed the same way twice.

Guide does have a truly brilliant feature. The cursor changes shape depending on the type of button to which it currently points. Each button type switches the cursor to a distinct shape, so you have an instant clue to not only what the button does but where its boundaries lie.

Fields

Fields have already crept into this discussion in the sections above, although Guide uses no fields because of its scroll-like implementation. In Hypercard and Linkway, fields are display objects that contain text data. They are rectangular areas of the screen that may or may not have graphical boundaries. In Hypercard, they may also function like buttons in that they may call Hypertalk scripts and therefore may be clicked on to initiate actions, a feature that gives tremendous power to the developer. Hypercard fields may also be scrolled, giving each card unlimited virtual size. Hypercard fields also have all the same object properties as buttons, so that they may be hidden, shown, or modified by Hypertalk commands.

Linkway's field object also stores text data, but that is about all that it does. It cannot scroll text beyond its physical boundaries, so what you see on the display is all that you get.

Although Guide has no fields *per se*, a button may be used to open another Window displaying another guideline. You may then scroll through the new window with all functions intact because it is another complete guideline in its own right.

Graphics

Hypercard allows you to display graphical images in either or both of two layers, the background and foreground of each card. The images may be of any size and shape and can underlay or overlay any of the other Hypercard objects, which may also reside on either layer. The graphics may even be changed by a command script, because Hypertalk contains drawing commands that can address the picture data in either layer, although for most purposes the images present on any given card are fixed. In practice it is far quicker and easier to go to another card with a new graphic but with identical functional objects than to redraw the layers. Incidentally, displaying in rapid succession cards with slightly different graphics allows you to perform simple animation sequences.

Linkway handles its graphical data in a totally different fashion. All pictures accessed by Linkway reside in external files that are addressed by either a picture object or a picture pop-up button. A picture object is a rectangular field that reads the data from the external file and displays it on the page. The picture object may be of any size up to the full area of the display. It overlays any other Linkway objects except one, and so may be used to hide unwanted buttons on certain cards. The exception is the only Linkway graphic element that actually resides with the page — the line/box. This feature was obviously implemented to allow you to make borders for your fields and buttons (since a picture object would block out any object beneath it) and will overlay any other object on the page.

The picture pop-up is a button that, when clicked on, overlays a smaller rectangular clipping of an external picture file on any part of the display. I say "smaller" because Linkway's size limitations come into play again. Pictures that are popped up may not exceed a certain size (about 400 "characters" worth of area in EGA mode, or about 6.25 % of the typical EGA display size). These pop-ups are very useful, however, because they allow you to make interactive changes to a larger picture object by placing pop-ups on it based on user choices. A picture of a retinal hemorrhage, for example, can be overlayed onto an image of the healthy eye at the click of the button. Linkway can also achieve simple animation by the page flipping technique.

Guide's graphics, as mentioned earlier, are treated as a part of the text stream. This does not mean, however, that they cannot be large and spectacular. Also, because the Guide/Windows interface allows you to open multiple windows/guidelines simultaneously, you can display several arbitrarily chosen pictures at one time. You cannot do this in Hypercard or in Linkway. Guide graphics may be buttons although you cannot overlay a single large picture with transparent buttons as you can in Hypercard.

One final note on graphics: Hypercard currently is confined to monochrome display, even on Macintosh II or later machines. Guide and Linkway can use color at the best resolution of the EGA/VGA graphics standards.

APPLICATION LAYOUT AND DESIGN

How easy or efficient is the use of the features mentioned above? Hypercard is a clear winner in the layout/design phase. Hypercard's ability to access the standard Macintosh clipboard and Macintosh DA's (Desk Accessories—small applications accessible at any time through the menu-bar of any main application) give it instant access to text and graphics created in other applications and stored in the Mac scrapbook or clipboard. It also has the ability to cut and paste its own objects. Guide, of course, can also utilize the Windows clipboard feature and can cut and paste its own objects, but Windows does not have a scrapbook. Linkway has its own internal clipboard for its own objects, but this clipboard cannot access text or graphics material from external applications, and it cannot cut and paste bodies of text between Linkway fields — a major obstacle that considerably slows folder building.

Hypercard's use of the standard Mac click and drag interface makes stack layout intuitive and incredibly quick. Objects can be selected, moved, and resized at a click of the mouse. Editing objects is a little more lengthy. You first double-click on the object, then work your way through a pop-up window that lets you alter object attributes or access other pop-ups, such as the script editor or the text style selector. All the information and tools are still there, however, easily discernible and available from the standard Mac pop-up tools (eg, dialog boxes, radio buttons). The presence of a background and foreground layer in each card also gives you tremendous power, because backgrounds may be duplicated, then overlayed with new foregrounds. All the attributes of the copied background travel along during the copy. All changes to this background automatically affect all cards with the same background, making revisions quite easy.

Linkway's author must be complemented on the amount of power included in his package, given that it runs under MS-DOS. Linkway provides a pull-down menu-bar interface similar to that used on the Mac and in Windows and makes a valiant attempt to give you true point and click access to objects. It even bests Hypercard in that it will let you select any object you can point to regardless of type. Hypercard requires you to have first selected a button, field, or graphics tool to work on these respective objects. It also lets you execute objects you are currently editing by double-clicking on them (in Hypercard you must go to the menu-bar and select the "hand" tool before you can actually execute your objects). It also has a pseudo-background called the base page, whose objects appear on all other pages in a given folder. You are limited to one base page per folder, but it is still a useful way of building in common features.

Unfortunately, there are certain inconsistencies in Linkway's point and click implementation. You cannot simply point at your objects and drag or resize them at will. You must (through choosing a menu option) decide before you click on a field or button if you are going to simply "move" it or "move and resize" it. Your resizing is also limited to dimensions measured in character-sized units, not in pixels. Also, Linkway's clipboard feature (which can only handle pages, buttons, and fields, not text or data) requires up to five separate mouse actions to complete a cut or paste. This is in marked contrast to Guide and Hypercard, where the operating systems provide such functions with a single mouse click followed by a single keystroke combination.

Guide implements all the basic point and click functions of Microsoft Windows, and so it is almost as easy to work with as Hypercard. However, it is somewhat pointless to discuss layout with applications that may appear in differently sized windows each time they are opened. Guide always opens a guideline to the size, shape, screen location and point in the text in effect when the guideline was last saved. Guide does not resize its own window, however, and since the guideline window appears inside the Guide window, results are unpredictable. This is quite an obstacle to the development of applications such as tutorials where the end user is often very unfamiliar with computers and requires operations to occur in an identical, predictable fashion.

IMPORTING DATA

Hypercard does well in this category largely because of its scripting language, Hypertalk. Although Hypercard cannot directly open a text file from an external word processor by a pull-down menu option, it is very easy to write a small Hypertalk script to load such a file into a field. With a little more effort, complex external data can be read, parsed, and distributed into various cards, fields, and buttons, all of which can be created at the behest of the script. Hypercard therefore is capable of intelligent data importation, a key requisite if you intend to deal with large amounts of pre-existing data.

Guide can open text files as easily as it can open its own guidelines. You can thus import a completely finished, edited document from your favorite word processor and then go through it to add your buttons and other features manually. Unfortunately Guide, which lacks a true scripting capability, cannot perform intelligent data importation. It comes in as a chunk, or it doesn't come in at all.

Linkway is better than Guide at handling external data but has several limitations. Using Linkway's native text editor, you can open and edit any external text file (those in ASCII format, of course), but you can't transfer that data into a Linkway folder from the editor! You can at least write a Linkway command script capable of intelligent data importation, and this script can indeed parse the data and place it into new pages and fields. However, to script anything really fancy, you will soon run into the 3000 character script size limit. The scripts can call external object code routines, but then you must know how to program in another language. Scripts can also call other scripts, but not as subroutines—complete control transfers to the new script. You can still accomplish sophisticated operations, but expect to invest extra effort to do so.

CREATING TEXT, GRAPHICS, AND DATA FROM WITHIN THE DEVELOPMENT ENVIRONMENT

Hypercard and Guide are both well suited to internal data creation, although Hypercard excels as a data collection tool because of its extensive scripting ability and flexible layout. Hypercard can be programmed and designed to act very much like a database entry screen, whereas Guide's performance in the data entry area is more akin to that of a word processor. Both packages let you specify font size and style with a sweep of the mouse, although Hypercard cannot change font styles of button names and limits field text to one overall font and style. In Guide you must be careful to select styles that will not conceal your button text, because button text is styled according to the type of button.

Linkway has a few minor problems in this department. You may, of course, type data directly into Linkway fields and pop-up buttons, but the editor features of these objects are primitive and inconsistent. Fields, for example, will not wrap text to the next line if you keep typing. You must insert explicit carriage returns to format field text, although pop-up button text does wrap automatically. The backspace key deletes previous characters in some text objects but not in others, and when typing text in a field, the insert key does not toggle an insert mode, as most users have been trained to expect, but rather inserts a blank space. Moreover, the function keys that delete or insert lines in the Linkway text editor do not all work in all the various objects that can take text input. Another limitation is the inability to cut and paste text within an object or between objects.

Turning to the graphical design of applications, Hypercard has its own internal "paint" utilities that can be used to create graphics. Hypercard's tools are not as sophisticated as those found in stand-alone graphics packages, but they include cropping tools, cut/duplicate/paste abilities, and a "fatbits" or enlarged mode for easy micro-touchup. Very respectable artwork can be created in reasonable time using Hypercard's internal mechanisms.

Linkway does have a paint utility but provides only a bare minimum of tools. There is no enlarged option — you must perform pixel-by-pixel editing on EGA resolution screens at the true size view. You may cut, duplicate and paste snippets of pictures within one file, but the screen redraw speed when doing so is distressingly slow, making accurate placement very tedious. The size of your clippings is also limited. You cannot cut and past large objects.

Guide has no native graphics creation capability. All graphics,including small ones used to represent buttons, must be imported.

ACCESSING EXTERNAL PROGRAMS OR HARDWARE

Programming in modules is becoming increasingly popular to the modern developer as source code toolkits of fast, efficient, often-used routines become available for the latest generation of developer-friendly C, PASCAL, and even BASIC compilers. Compiled once, these routines are collected into libraries of object modules that can be incorporated into many different applications with no additional programming time. Many code libraries are available to drive hardware such as videodisc or videotape players.

Hypercard was designed to take advantage of these routines through Hypertalk's ability to call XCMDs (eXternal CoMmanDs) and XFNCs (eXternal FuNCtions). These externals are code resources that can be permanently attached to your stacks by using a Macintosh software utility like ResEdit (Resource Editor) or ResCopy (Resource Copier).

You may write and compile your own resources or shop for them among hundreds that are available as shareware, public domain software, or commercial packages. There are even public domain Hypercard stacks that assume the functions of ResEdit or compile Hypertalk scripts into the faster, smaller external routines. The ready availability of so excellent and varied a selection of resources gives Hypercard a good rating in the external calls category. How has such a cornucopia come about? The developers of Hypercard were careful not only to give the XCMD/XFNC interface access to the data internal to the calling Hypercard stack, but also to document and to publish the source code necessary for doing so.

Linkway also rates high in this area, providing several ways to call external programs. One is the simple but useful ability to launch a DOS command or executable program that runs and then returns control to Linkway. It is important to note, however, that because the Linkway code and the folder file must remain resident in memory to run, the memory left for running external resources may become minimal.

Another Linkway script command can call an external routine written and compiled in some higher language, treating it like a subroutine. External subroutines may be handed pointers to the memory locations of Linkway folder data, so that they may directly access the data in your applications. Still more Linkway script commands can be used to address the serial communications ports directly. Serial communications capabilities must come to Hypercard as XCMDs or XFNCs.

Guide falls short of its hypertext brethren in the category of external calls. It is true that Guide is sold with two interpreters, one of which allows calls to the serial ports, while the second launches other Windows applications. It is also true that you may purchase an "Interpreter Development Toolkit" that allows you to develop your own interpreters. However, this toolkit requires that you have the Windows Development Kit from Microsoft and are a competent Windows programmer. The real, "however" is yet to come. None of the interpreters (even those you develop yourself) can access the data internal to the calling Guideline. You may not even pass variables or parameters to these interpreters. In other words, every interpreter call must be explicitly typed. You can send string "Play until frame 600" to the serial port, but you cannot send the contents of a variable X to that port.

SECOND THOUGHTS

Intelligent outlining and preliminary design should eliminate the need for extensive, late-in-the-game revisions to applications. This is true . . . sort of. Sometimes late breaking news forces a content change. Sometimes a last minute inspiration hits you for the perfect feature. Can you perform these revisions without disemboweling your creation?

Hypercard's point and click interface, self-modifying capabilities, and ability to edit a background layer that affects every card using that background let you do a reasonably quick major revision — if you have avoided certain design elements. For example, if you want to italicize a word in a text field to represent a button, you must overlay that word with another, tiny field with the italic text style set and the appropriate script attached. If you reformat the underlying field because you need to add a sentence, you must manually move the tiny overlay field. One such move can be done quickly, but suppose you have an entire page full of text with ten italicized terms, or a full-page graphic with an overlay button on each part?

Linkway, because of its somewhat primitive editing tools, runs into a few problems in the modifications department. It lacks the ability to use the mouse to point and select more than one character of text, has no text clipboard, and has no word-wrap feature. These deficiencies make text modifications very painful. You are usually faced with retyping entire paragraphs if you want to add or delete even one long word. Modifying pictures is somewhat easier, because you can simply make a copy of your picture file, give the copy another name, modify it, and hand the new name to the picture pop-up you already have on your page.

Guide, with its similarity to a physical scroll, has less imposed structure than its stack oriented competitors and therefore is often more easily revised. No matter how much text you add or delete, your buttons always remain attached to the correct words since those words are the actual buttons. However, if your guideline is lengthy, and you

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have made extensive use of replacement buttons, it is very easy to get lost. If you are not careful, you could bury a hefty chunk of your guideline in an unwanted replacement button or misplace a link to significant blocks of text. Lack of smaller structural objects like cards/pages and an inability to obtain some kind of overview of the replacement/link structure of a guideline can make fixing such gaffes almost impossible. Conclusion: Careful preplanning is a must for good development work in all three packages.

CUSTOMIZING APPLICATIONS

Many of the previous sections have been sprinkled with allusions to scripting languages, Hypertalk routines and the like. Those of you who have managed to stay awake this far into the article will be rewarded with some minor illumination of these terms. The issue in this section is whether the hypertext package in question has only the features included by its makers or whether it can be extended, automated, or enhanced through more programming, by you, its prospective owner. Such capability is often desirable because it allows you to customize and personalize your applications, tailoring them to your own or to your client's exact needs.

Hypercard's programming language, Hypertalk, the subject of several books, is already a software household word. It is, to some extent, an archetype by which other hypertext scripting languages are judged these days. It is quite impressive in many respects, not only because of its internal capabilities but because of the flexibility and consistency of its implementation. Any Hypercard object (field or button) may have a Hypertalk script attached to it. All the scripts are invoked by messages that are either stopped by a script or passed through it to the other scripts, at the scriptor's discretion, in a clearly defined and documented order of precedence. This gives the developer great flexibility of calling and control. Scripts may also send standard or custom messages and so effect subroutine-like calls, as well as call XCMDs that become transparent additions to the Hypertalk lexicon when attached to your stack.

It is also possible to construct user-defined functions of sorts. The scripts may create and use variables that can contain data of up to 32 kilobytes and that may be declared as global in scope. Hypertalk contains commands that allow it to open and read external files in block mode, so importing large amounts of data is quite practicable.

Higher order language features such as arrays are, unfortunately, not supported. Professionals used to languages like C and Pascal have expressed despair at Hypertalk's rather casual, unstructured nature. For many people, however, the lack of restrictions will prove to be a blessing. Just don't develop too many bad habits. Hypertalk will do what you want most of the time, and when it doesn't, you will probably be able to find an XCMD/XFNC to do the job.

Sadly, the Hypercard script editor is the package's least polished element. It appears in a fixed-size window and does not allow access to the Macintosh Desk Accessories. Still, the clipboard is supported, and all of the standard editing keystrokes and mouse functions are retained. There is even a primitive print option that dumps your script to the printer in a nine point Geneva typeface.

Linkway also comes out of its box equipped with a scripting language. This language contains many commands that can access external code resources. It can also address the data in Linkway fields and pop-up buttons, or even execute those buttons, but unlike Hypertalk, it cannot directly address Linkway's own menu options. Linkway scripts can create new pages in a folder, but they must be exact copies of a previously existing page stored in Linkway's page clipboard. Fields may have data written into them, but new fields cannot be created from within a script. There is no inherent provision for subroutine calls, although you may, of course, invest the effort to write a pointer system to mimic such a feature (using up a part of the precious 3000 characters available to each individual script). There is no provision for user definition of functions. Block-IF control structures are supported, as is GOTO (called "jump"), but that is the limit of the flow control repertoire. Variables must be declared with a maximum length in bytes (characters), and although the manual tells you that the upper limit on size is 32000 bytes, the software,with repeated error messages, will haggle you down to 3000 at most.

I should also reiterate Linkway's 3000 byte limit on scripts, which is not very much space in which to make a primitive language perform sophisticated operations (To give you an idea of scale, a standard 80 x 25 screen display holds 2000 characters). It is far too much space, unfortunately, for Linkway's native script editor, which, like Hypercard's, appears in a fixed-

EDITOR'S NOTE

Due to space limitations, **Keeping Abreast of the Literature,** CLSE's regular quarterly feature due to appear in this issue will appear in next month's issue.

size window, but unlike Hypercard's, uses a bare fraction of the screen space. Linkway's script editor also suffers from the edit-key inconsistencies prevalent in the rest of the package.

A Linkway script function is provided that will read a script into a variable from an external text file which can, of course, be edited using any word processor, or Linkway's text editor. This variable can then be executed by the calling script. This allows for longer virtual scripts but again provides no inherent subroutine capability. If this deficiency were to be remedied, the power of Linkway scripts would increase exponentially. At present, although you can perform many useful small-scale customizations, large, serious routines require much extra effort to implement.

There is nothing to say about Guide in the scripting language department, for the simple reason that it has no such feature.

CONCLUSION

Bear in mind that the above evaluation is subjective, as any such evaluation must be. What is a major deficiency or advantage to one reviewer may not be important to you and your needs. What is certain is that all three of these packages provide development opportunities both for computer specialists and for people who previously would not have had the training or means to develop their own applications. This is perhaps their most exciting feature — that one does not have to be a computer wizard to get good value from them.

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CONTENTS

HYPERTEXT AS AN AUTHORING ENVIRONMENT 73
Harold I. Modell

KEEPING ABREAST OF THE LITERATURE 79

HYPERTEXT AS AN AUTHORING ENVIORNMENT

Harold I. Modell

National Resource for Computers in Life Science Education, Seattle, Washington

Within the past several years, we have become familiar with the concept of hypertext. Shneiderman and Kearsley [2] have recently published an excellent introduction to hypertext that includes software allowing the reader to experience the concept.

The philosophy underlying the concept is that users should be able to access data within a database in a nonlinear fashion. To do this, links are established between information in the database, and the user may browse through the database in a fashion consistent with that user's individual approach to the data. The concept is illustrated by the screen shown in Figure 1. This screen shows a series of study questions related to respiratory physiology. Using a mouse, the users can click on the underlined words to gain additional information about the terms; they can click on the question number to move to subsequent screens addressing each question; or they can click on the arrows at the bottom right of the screen to more forward or backward in linear fashion through the series of screens.

The advent of hypertext applications that include provision for graphics, sound, and access to other technology (eg., videodisc), like Hypercard for the Macintosh and LinkWay for MS-DOS equipment, have extended the hypertext database concept to a hypermedia concept. Rather than dealing with a database consisting entirely of text, these applications allow the database to include graphics, sound, animation, and a variety of media combinations. The growing number of "stacks" available either commercially or on a shareware basis attests to the popularity and ease of use of the hypertext environment.

In his recent comparison of hypertext applications, Frkonja[1] discussed the notion of "buttons" that allow the devel-

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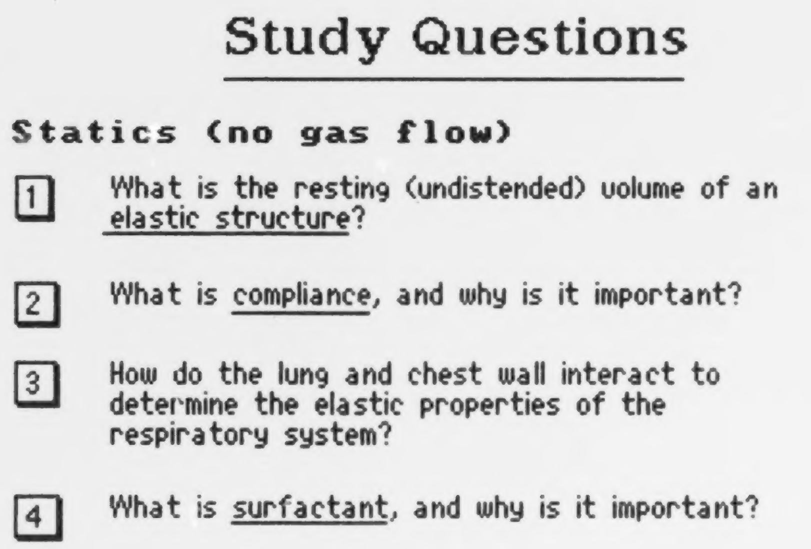

Study Questions

Statics (no gas flow)

1 What is the resting (undistended) volume of an elastic structure?

2 What is compliance, and why is it important?

3 How do the lung and chest wall interact to determine the elastic properties of the respiratory system?

4 What is surfactant, and why is it important?

FIGURE 1. Study questions in a hypertext format from a tutorial dealing with respiratory physiology. Students can move through the set by a variety of routes. By clicking the mouse on the underlined words, they can access additional information; clicking on a question number takes them to screen dealing with the specific question; or they can move through the screens in a linear fashion by clicking on the arrows.

oper to create pop-up windows of either text or graphics. He also noted that both Hypercard and LinkWay include a "scripting" language that allows the developer to customize the applications through a series of small programs.

The range of capabilities of this software and the fact that the mouse (or other pointing device) plays an integral role in the user's interaction with the software, raises the question of how well this environment can serve as an authoring environment for interactive tutorials.

The purpose of this article is to explore this question. The examples used are drawn from a tutorial currently under development dealing with respiratory physiology. This tutorial is being written initially using LinkWay. The reasons for choosing LinkWay are unrelated to the software *per se*. Frkonja[1] has noted that customizing applications in LinkWay may be somewhat more difficult than in Hypercard, so while our examples may not represent the easiest way to implement particular aspects of the tutorial, they fulfill our requirement of being able to run on MS-DOS equipment.

WHAT CONSTITUTES A TUTORIAL?

We must first define what constitutes a tutorial. A tutorial is a primary learning experience in which the student is an active participant. This participation must have an intellectual component, so that mere "page turning" or "browsing" does not constitute participation. In general, the format is to present the student with some basic information and then have him or her use that information to examine the underlying concept. Whenever possible, problems or questions should be stated so that they illicit an uncued response. Thus, multiple choice questions should be kept to a minimum, or, if necessary, used to help students understand what is being asked. When responses are incorrect or indicate a lack of understanding, appropriate "dialog" designed to help the student understand the problem solving process or the underlying concept should ensue.

PRESENTING BASIC INFORMATION

Didactic presentation of information in hypertext applications can be varied. The traditional presentation of text and graphics shown in Figure 2 is certainly one possibility. However, depending on the available technology, other possibilities include animation, sound, color, videodisc material, or integration of these modalities. Implementation of specific screens is accomplished through placement of various types of text fields or graphics windows. Specifying and placing these fields and windows involve few steps and are easy tasks to complete.

The hypertext applications also allow one to easily accommodate a variety of students backgrounds. By linking information on the screen with "pop-up" boxes or other screens, the author can provide students with easy access to definitions or other relevant background material for the information in the primary presentation.

It is also easy to incorporate a variety of review paths for the student. When viewing the screen shown in Figure 2, for example, the student can move, at any time, to screens that were viewed prior to the current one, or he may go back to the study questions.

COMPUTER-STUDENT INTERACTION

Simple options

Perhaps the simplest type of computer-student interaction is illustrated in Figure 3. This exercise draws on the material presented on the screen shown in Figure 2. The student's task is to decide if the elastic structure shown is larger or smaller than its resting volume. To indicate the answer, the student simply points to the appropriate box and presses the mouse button. If a correct response is given, a pop-up text window that can be scrolled is presented with information reinforcing the correct answer (Figure 3B). If the incorrect response is given, a dialog is begun that helps the student in a step-wise fashion through the approach taken to solve the problem.

These options are accomplished by placing a masked script button over the

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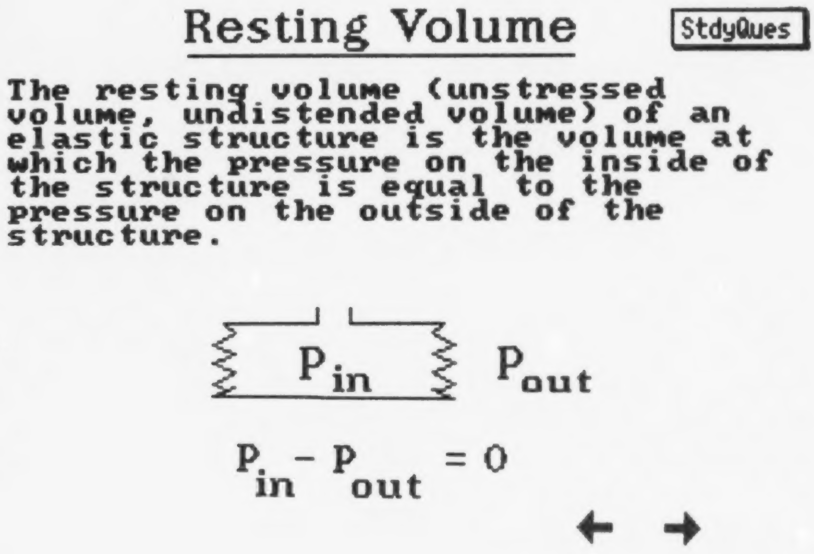


The resting volume (unstressed volume, undistended volume) of an elastic structure is the volume at which the pressure on the inside of the structure is equal to the pressure on the outside of the structure.

$$P_{in} - P_{out} = 0$$

FIGURE 2. Traditional didactic presentation of graphics and text in a hypertext environment. By clicking on the arrows, students can move to previous or subsequent screens. They can also return to the study questions by clicking on the "StdyQues" box.

box surrounding each choice. By clicking on a box, the student activates a small program in the script button. The script in the correct box simply directs the program to activate a pop-up text window containing the reinforcing response. The script in the incorrect box sets up a dialog with the student (Figure 3C) designed to help him recognize that Pin-Pout for this structure is greater than zero. A branching scheme is included in the script so that a second level of correction is available. Upon completion of the dialog, the student is given another opportunity to answer the original question. A counter is included in the script so that, in the event that the question is answered incorrectly again, the student is presented with the rationale leading to the correct answer.

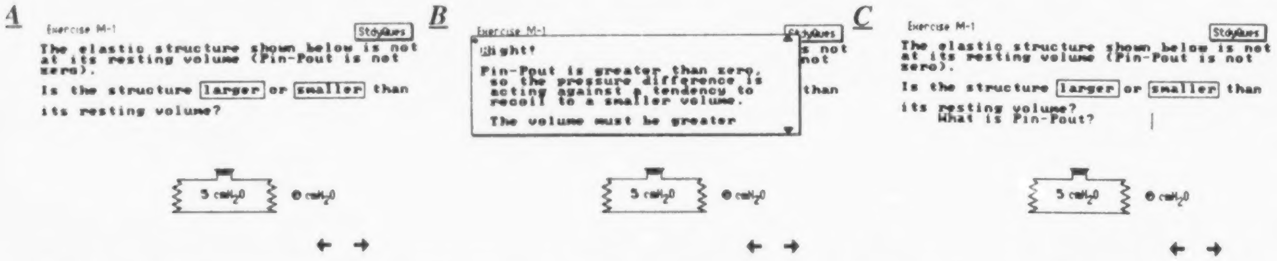
Uncued answers

The screens shown in Figure 4 illustrate a situation in which the student is asked to point (and click) on one or more relevant points on a curve. The student initiates the governing script for this exercise by clicking on the box marked "Begin Exercise." In this case, invisible, empty text fields have been placed over the regions representing acceptable answers to the questions that will be asked. In Figure 4B, the region outlined by the dotted box indicates the tolerance given for the point representing the resting volume of the structure. Each of these fields is given a name, and the script includes a statement telling the program to wait until the mouse button is pressed. The script then checks to see if the object being clicked on corresponds to the appropriate empty text field. If it is, a pop-up text window reinforcing the correct answer is presented (Figure 4C). If it is not the correct response, the script presents review information that should help the student identify the correct point, and the student is given a second chance. If the student again fails to identify the correct point, the correct answer is presented (Figure 4D).

The option of using the mouse to identify points on graphs or portions of pictures increases the potential of eliminating cued questions (eg, multiple choice) and enhances the opportunities for the student to engage in a problem-solving process that is more akin to the one he or she will use in solving "real" problems.

Combined options

Our final example, shown in Figure 5, employs a variety of interactions to establish a dialog designed to build on the information presented in earlier screens and lead the student to the conclusion that, at the resting volume of the respiratory system, intrapleural pressure is negative with respect to atmospheric pressure. The interaction involves uncued answers, multiple choice options,



A: The elastic structure shown below is not at its resting volume (Pin-Pout is not zero).
Is the structure larger or smaller than its resting volume?

B: Right!
Pin-Pout is greater than zero, so the pressure difference is acting against a tendency to recoil to a smaller volume.
The volume must be greater

C: The elastic structure shown below is not at its resting volume (Pin-Pout is not zero).
Is the structure larger or smaller than its resting volume?
What is Pin-Pout?

FIGURE 3. Example of one multiple choice format. *PANEL A:* The problem is stated, and the student indicates a choice by clicking on a box with the mouse. *PANEL B:* A pop-up text window is presented in response to a correct choice. The text in the window scrolls. *PANEL C:* An incorrect answer initiates a dialog designed to help the student think through the problem.

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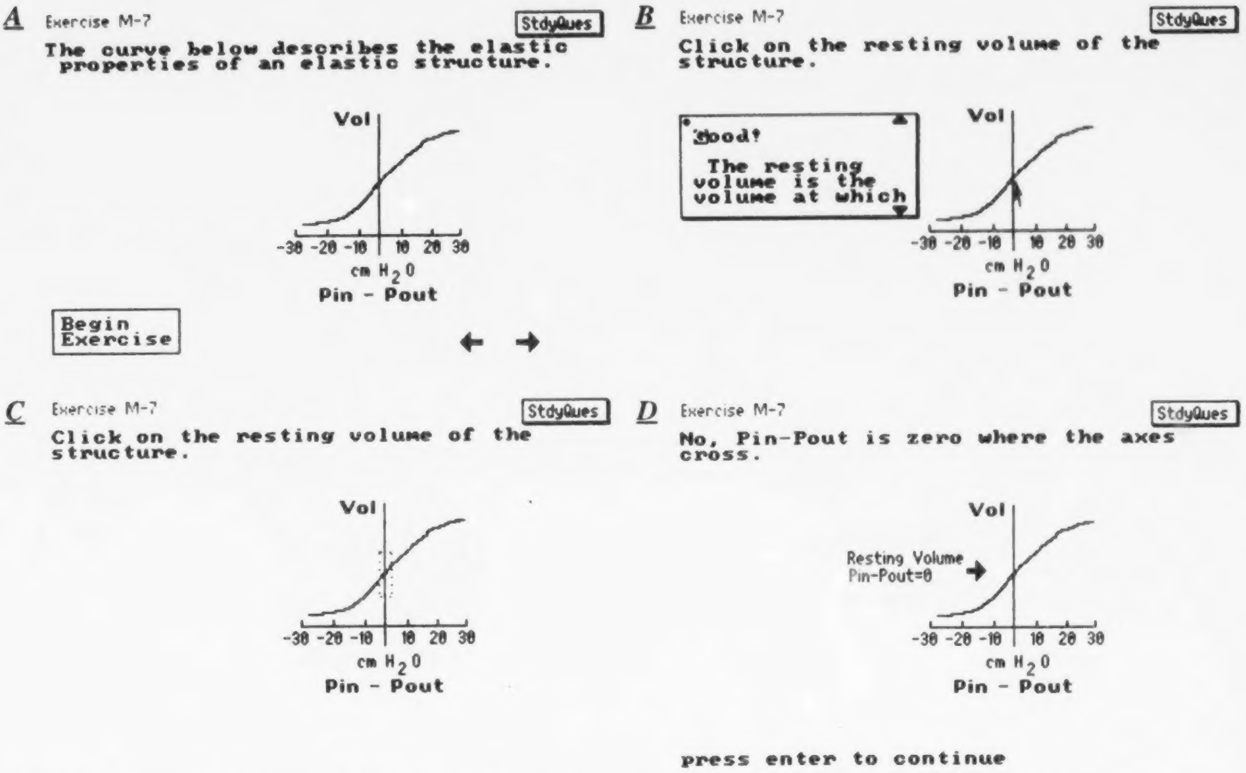

Exercise M-7

The curve below describes the elastic properties of an elastic structure.

Exercise M-7

Click on the resting volume of the structure.

Good!

The resting volume is the volume at which

Exercise M-7

Click on the resting volume of the structure.

Exercise M-7

No, Pin-Pout is zero where the axes cross.

press enter to continue

FIGURE 4. Example of a computer-student interaction involving uncued answers. *PANEL A:* The initial screen. The student begins the dialog by clicking on the "Begin Exercise" box. *PANEL B:* The problem is posed. Dotted rectangle, hidden from the student, indicates the region of acceptable answers. *PANEL C:* Reinforcement is presented when the correct point is identified. *PANEL D:* If, after receiving help, the student is still unable to identify the correct point, it is identified for him.

sound cues, and didactic presentation of information.

Figure 5A shows the first screen in the series. As in the earlier examples, the student can go back either to previous screens or to the study questions before beginning the exercise. To begin the exercise, the student clicks on the box in the lower left corner of the screen.

The first task encountered is the uncued question shown in Figure 5B. The purpose of the exchange is to help the student visualize the location of, in this case, Pin of the respiratory system. Upon successful completion of the task (Figure 5C), a reinforcing message is presented. The script inserts a pause at this point to give the student time to read the response. A tone is sounded at the end of the pause, and the first entry in the table is entered by the program. The second task is then presented (Figure 5D) after another brief pause. After locating Pin and Pout for the total system, the student is presented with a question (Figure 5E). A pause of several seconds is also inserted at this point to give the student time to think about the answer before the multiple choice options are presented (Figure 5F). During the pause, the student could be thinking of one of several ways to answer the question (eg, Palv-Patm, zero), all of which may be relevant to the concept addressed. The multiple choice format in this instance indicates to the student what level of answer is desired. The student indicates her answer by clicking on the appropriate menu item.

The dialog continues in a similar fashion until the student has dealt with each item in the review table and with the relationship between intrapleural and atmospheric pressure at the resting volume of the system.

IMPLEMENTATION

Using the hypertext applications (Hypercard or LinkWay) to implement the computer-student interaction illustrated in our examples is not a difficult process. The software is generally user-friendly, and several implementation options may be possible for each presentation task. However, each of the hypertext applications has limitations that may lead to a certain amount of frustration.[1] Nevertheless, many of these limitations can be overcome in a variety of ways to yield a useful tutorial. To illustrate, let us consider some of the issues encountered when implementing the series of interactions partially shown in Figure 5.

The purpose of this series of interactions is to engage the student in a dialog designed to review and extend the

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previous discussion. The final result is a review table and a pop-up text window reinforcing the concepts discussed. The student interaction involves several modes and helps the student (hopefully) to understand the reasoning behind our conclusions regarding intrapleural pressure. We have chosen to use CGA graphics for this tutorial, so the graphics resolution and the available color options are somewhat limited.

Screen layout

The screen is layed out with three key areas. The table occupies the upper portion of the screen and includes some text that will remain throughout the interaction (the table labels) and some text that will be added as the interaction proceeds (the table entries). The lower portion of the screen contains the graphic and a text region in which most of the dialog takes place. Other features may overlay these areas as the dialog proceeds (eg, the answer menu shown in Figure 5F), but the primary focus is on the key areas.

The table labels are placed on the screen in a text field, and this field remains unaltered throughout the interaction. The table entries are each defined by a separate text field that overlays the label field (see Figure 6). Each of these fields is given a name so that it can be accessed and filled through a set of script (program) instructions.

The text region in the lower portion of the screen is also named so the text residing in the field can also be governed through script instructions.

The graphic is placed on the screen through a picture field. In LinkWay, the picture is saved in a disk file and accessed by LinkWay when the screen is displayed. Figure 7 shows the outline of the picture window with a named text field overlayed over the "lung" bellows. Similarly, the regions between the two bellows are overlayed with two other text fields. These fields are used to determine the region identified by the student when she is asked (eg, as in Figures 5B and 5C) to click on a specific region of the diagram.

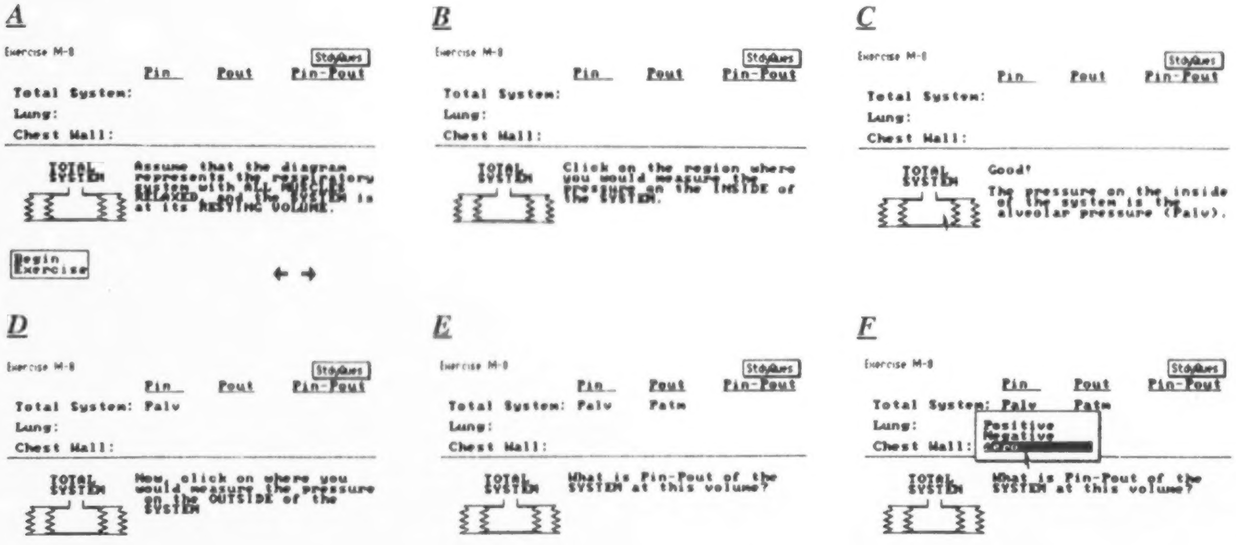
Flow control

The flow of the interaction is governed by a series of script instruction sets. When the student clicks on the box marked "Begin Exercise," the following script button (set) is activated.

```
var c(2);
set c=0;
set lft="";
set rt="";
do control;
```

This script defines a variable, c, that will be no longer than two characters. It then sets the value of c to 0. This variable will be used as a switch to direct flow control among several sets of script instructions (script buttons). The instructions mask the "previous screen" and "next screen" arrows and then transfer control to another script button named "control," the contents of which are listed below.

```
 if c=1
   {load lung, "lung18.sct";
```



A: Assume that the diagram represents the respiratory system with ALL MUSCLES RELAXED, and the SYSTEM is at its RESTING VOLUME.

B: Click on the region where you would measure the pressure on the INSIDE of the SYSTEM.

C: Good! The pressure on the inside of the system is the alveolar pressure (Palv).

D: Total System: Palv. Now, click on where you would measure the pressure on the OUTSIDE of the SYSTEM

E: Total System: Palv Patm. What is Pin-Pout of the SYSTEM at this volume?

F: Total System: Palv Patm. What is Pin-Pout of the SYSTEM at this volume?

FIGURE 5. Example of computer-student dialog involving a variety of interaction modes. *PANEL A:* First screen in the series. The student begins the exercise by clicking on the "Begin Exercise" box. *PANEL B:* The student is asked to identify a region of the picture. *PANEL C:* The student receives reinforcement for a correct answer. A pause is inserted before the computer makes the first table entry. *PANEL D:* After the table entry is completed, the program pauses briefly and then presents the second task. *PANEL E:* In this case, the student is presented with a question to answer. A pause is inserted after the question is presented. *PANEL F:* After allowing several seconds for the student to think about the question, the program present a menu of answers. The student indicates a choice by clicking the mouse on a menu item.

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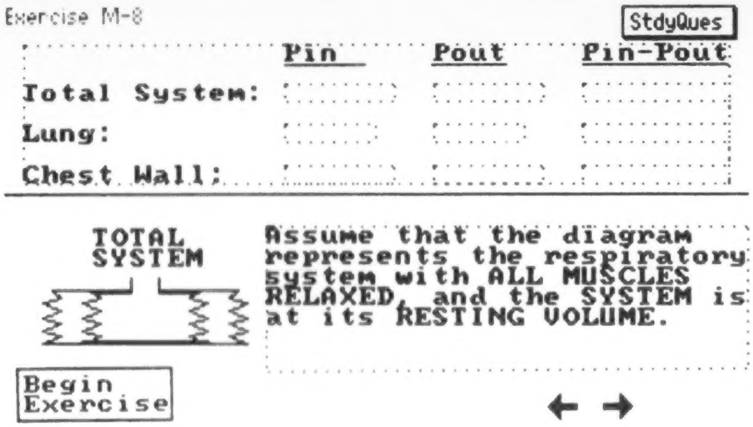


Assume that the diagram represents the respiratory system with ALL MUSCLES RELAXED, and the SYSTEM is at its RESTING VOLUME.

FIGURE 6. Text layout for screens shown in Figure 5. The dotted rectangles indicate individual text fields. See text for details.

```
      script lung;}
   if c=2
     {load chest, "chest18.sct";
      script chest;}
   if c=3 do reset;
   do system;
```

This instruction set illustrates how other script sets can be used as subroutines even though LinkWay does not formally support subroutines. The variable, c, takes on the values of 0, 1, 2, or 3. Depending on its value, flow is transferred to a subset of instructions. The subset concludes by reassigning a value to c and returning the flow to this set.

This set calls other scripts in two ways. The least complicated happens when c is 0 or 3. In these cases, control is transferred to other script buttons ("system" and "reset"). When the value of c is 1 or 2, new variables are defined ("lung"; "chest"), disks files ("lung18.sct"; "chest18.sct") are loaded into these variables, the variables are then defined as script instructions and are executed.

The ability to store script instructions as text files enabled us to overcome some of the storage restrictions imposed in LinkWay. In this series of interactions, the student deals first with relationships for the total respiratory system. The process is then repeated for the lung and chest wall. When responses for incorrect answers are considered, the entire series exceeds the space that LinkWay allows for each screen. Using disk files for script storage provides an easy way of implementing the scripts without worrying about exceeding the storage capabilities of the screen or a script button.

Using script instructions to place text

We have used two mechanisms to present text to the student. The changes in the text region in the lower portion of the screen (tbox) shown in Figure 5 were accomplished with direct assignment statements. For example, the following script was used to replace the text in Figure 5A with the text in Figure 5B.

```
set tbox="Click on the region where
   you would measure the pressure on
   the INSIDE of the SYSTEM";
```

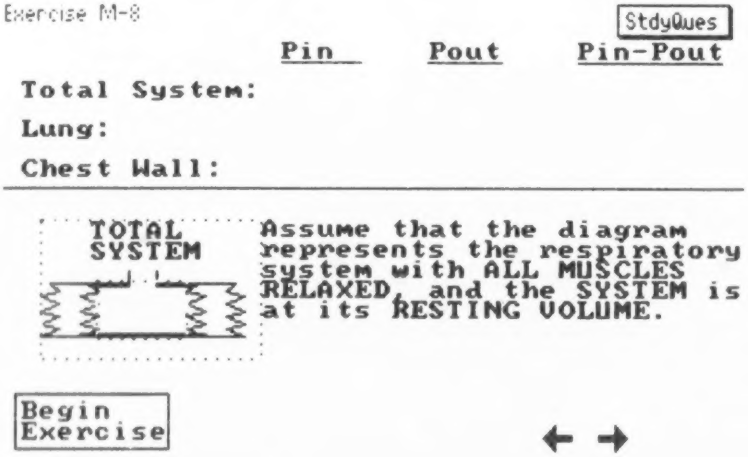
A second method of accomplishing this is to store text in a pop-up text window (invisible to the student unless activated), and assign the pop-up text window to the visible text field. For example the text presented in Figure 4B is stored in a pop-up window named "text1." The following script replaced the text seen in Figure 4A with that seen in Figure 4B.

```
set tbox=text1;
```

The sentence, "Click on the resting volume of the structure.", was placed directly into text1 as part of the screen set-up.

Other features

Other features such as using the mouse to identify objects on the screen, using pop-up menus for multiple choice answers, embedding pauses, and using audio cues (eg, beeps) are implemented



Assume that the diagram represents the respiratory system with ALL MUSCLES RELAXED, and the SYSTEM is at its RESTING VOLUME.

FIGURE 7. Layout for screens shown in Figure 5. The large dotted rectangle indicates the picture window in which the graphic resides. The smaller dotted rectangle is a named text field overlayed on the region defining the inside of the lung. This field is used to identify when the student has correctly clicked on this region. See text for details.

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by using one or two script instructions.

CONCLUSION

We have presented a rather limited view of how the hypertext environment can be used to author tutorials. When other features of the Hypercard and LinkWay are considered, such as the ability to access other applications, the environment offers a wealth of possibilities for educational software designed for use in classroom instruction or independent study. Consider, for example, the physiology tutorial used in our examples. Because both Hypercard and LinkWay can link to applications outside of the hypertext environment, students can move from a series of tutorial screens to simulations of the system in which they can test the concepts developed in the tutorial by manipulating data. Furthermore, when they have completed examining the model, they are returned to the same screen they were viewing prior to moving to the simulation. The versatility of the hypertext environment offers considerable potential as an inexpensive authoring environment for traditional tutorials and new approaches to computer-student interaction.

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KEEPING ABREAST OF THE LITERATURE

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

INTERACTIVE VIDEODISC SIMULATED PHYSIOLOGY LABORATORIES 81
Charles E. Branch, M. Slimp, B.T. Robertson, S.D. Beckett, M.M. Lewis, and Amy L. Fawver

THE BULLETIN BOARD 86

INTERACTIVE VIDEODISC SIMULATED PHYSIOLOGY LABORATORIES

Charles E. Branch, M. Slimp, B.T. Robertson,
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As teachers of physiology, we have traditionally relied on live animal laboratory experiences to supplement material presented in lectures. The justification for these laboratory experiments has been discussed at length.[4] One objective of live animal labs, demonstrating basic concepts, appears applicable to all students.

Due to increasing costs, reduced available time, and pressure from animal rights advocates, many schools have deleted or markedly reduced animal experiments in the basic sciences — in most instances with no attempt to provide an alternative or to test the effects of deleting the labs. Although no concerted effort has been made to develop alternatives, a few examples of computer simulations are available. We have experimented with some of these, and some are quite capable of helping to instill an understanding of concepts. However, we found many students to be unreceptive to the computer simulations, primarily because the simulations did not appear realistic to the students.

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Several years ago we began a project to develop realistic alternatives to some of the cardiovascular and respiratory physiology labs.[1] We chose to concentrate on interactive videodisc labs because their potential realism might provide motivation not provided by some of the traditional computer simulations. Hopefully once motivated, the students might then use some of the traditional simulations to broaden their understanding.

OBJECTIVES OF VIDEODISC LAB SIMULATIONS

The simulated labs have the following objectives.

1. Illustrate more physiologic principles and more variations than are possible in the traditional labs.
2. Reduce the faculty and student time spent in experimental preparation and operation of equipment.
3. Give students simulated experience with procedures that they could not safely or economically do in a real lab.
4. Compress time, so that students can see the longer term effects that we cannot demonstrate in a two hour lab.
5. Allow students to do the experiments and review the lessons at times convenient to them.
6. Conduct quantitative objective evaluations of the lessons, and make the lessons available to other educators for independent evaluation studies.

To date we have developed two videodisc lessons and used them with students. The first, a drill and practice lesson developed for internal use, was a simple collection of heart sound recordings that the students could use to gain experience with auscultation. That lesson, the techniques used for development, and the evaluation have been described elsewhere.[1,2,3] The second was a traditional cardiovascular lab that included experimental preparation, autonomic control, cardiac catheterization, fibrillation and defibrillation, a manometer experiment, positive pressure ventilation, and an animated presentation of the normal and abnormal cardiac cycle.

This article describes the Cardiovascular Laboratory (CVL) Videodisc and then describes the procedures used for its development. Hopefully the lessons we learned in this project will be useful to others who may be considering similar programs.

LESSON DESCRIPTION

The CVL lesson is intended for use by persons having no experience with computers. The programs include online instructions and a help key function, but most users are able to operate the programs without reading the instruction screens. The lesson uses a main menu for selection of chapters. Within chapters, the lessons are controlled by menus, submenus, and bar menus at the bottom of the screens. The programs track the user's progress by displaying asterisks beside menu items previously selected. The user may move forward, backup, branch to optional details, pause, jump to the end of video segments, repeat segments at will, return to menus, or gradually back out of the chapter. These controls help prevent the user from becoming lost.

A "slide carosel" function lets the user mark any sequence or screen and then go back later and play the marked sequences without having to maneuver through the programs. This feature may be used for repeatedly comparing sequences that are located in different parts of the program. Another use is to build up a customized list of sections the user would like to review later or perhaps discuss with an instructor.

The videodisc lesson contains 10 chapters on experimental preparation, autonomic control, cardiac catheterization, positive pressure ventilation, fibrillation, manometer experiments, the normal and abnormal cardiac cycle, and euthanasia.

A split screen shows actual polygraph recordings of blood pressure, respiration, EKG, heart rate, and carotid arterial blood flow in real time while a window insert simultaneously illustrates the procedures. Information from the computer is overlaid onto the videodisc images for program control and presentation of text information. Two separate audio channels provide narration and other audio information, such as a cardiac beeper or alternative narration versions.

The experimental preparation chapter includes anesthesia induction and intubation; cannulation of the femoral vein, femoral artery and jugular vein; setting up recordings of EKG, respiration, pressures, and carotid artery blood flow; and isolating the vagal nerves for stimulation.

The autonomic control chapter illustrates direct and reflex responses of the circulatory system to drugs, vagal nerve stimulations, and baroreflex tests. Injections of acetylcholine, phenylephrine, and isoproterenol illustrate the effects of stimulating specific receptors. Epinephrine injections illustrate more complex effects. Vagal nerve stimulations illustrate sinus bradycardia, AV block, vagal escape, and reflex responses. The baroreflex reflex experiments include carotid massage and bilateral carotid occlusion. In addition, injections of vasoconstrictors and vasodilators illustrate the overall baroreflex responses.

The cardiac catheterization chapter illustrates recordings from the right and left heart. Recordings are made as the catheter is passed into the chambers of

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the heart and then withdrawn. One recording illustrates pulmonary wedge pressure, and an animation illustrates the procedure. Another experiment illustrates catheter-induced premature beats with and without compensatory pauses.

Two chapters use animations to illustrate the normal and abnormal cardiac cycle. The animations illustrate the heart and recordings of EKG, left ventricular pressure, arterial pressure, ventricular volume, right atrial pressure, and phonocardiogram.

Other chapters illustrate the effects of positive pressure ventilation on the circulation, measuring pressures with a water manometer, fibrillation and defibrillation, and euthanasia.

RESULTS

The CVL lesson covers material previously covered in a series of one participation lab, one demonstration lab, and several lectures. A Preliminary version of the CVL lesson (without narration and without the cardiac cycle animations) was tested using 30 randomly selected first year veterinary medical students who used the lesson in place of doing the live animal experiment. The students rated evaluation questions on a scale of 1 (strongly disagree) to 5 (strongly agree). A neutral response was rated 3.

The videodisc students performed as well on the post test as the control students, and they required less time. The students rated the preliminary videodisc lesson as easy to use (4.53), reliable (4.43), acceptable video quality (4.30), acceptable and accurate content (4.46), and realistic (4.13). The students were very polarized on the issue of elimination of live animal labs, with 8 students favoring elimination, 21 students opposing elimination, and only one student neutral. However, the students did favor using the videodisc as an optional replacement (4.30). Based on written comments, many of the students who opposed mandatory replacement stated that they thought they needed the hands-on experience to prepare them for surgery courses.

Based on the evaluations, the lessons were modified, narration was added, and the cardiac cycle animation programs were added. A description of the formal evaluation of the completed CVL lesson is in preparation.

VIDEODISC LESSON DEVELOPMENT PROCEDURES

Using experimental protocols approved by the university animal welfare committee, seven experiments with anesthetized dogs were conducted to obtain both the video and physiologic data. The experimental procedures were recorded on 3/4 inch videotape. The video formatting was planned to permit later combination with polygraph recorder images during video post-production. Simultaneously, recordings were made of EKG, respiration patterns, blood pressures, carotid blood flow, and heart rate. The physiologic data were recorded on a six channel polygraph recorder (Beckman R-411) for record keeping and onto an eight channel FM tape recorder (Vetter Model A) for later conversion to video format. A single audio channel was recorded onto both the videotape and FM tape to aid in synchronizing the video and FM recordings during post-production.

The video and polygraph recordings were reviewed, and summary data of technical quality, video quality, physiological results, and durations of each recording were entered into a database management program. The database was manipulated according to various criteria to select the combinations of recordings that best illustrated the desired physiological variations with acceptable technical and video quality and within the available 30 minute limitation.

The selected recordings were played from the FM recorder onto another polygraph recorder (Beckman S-II) for conversion to videotape using a video camera mounted on the recorder. The audio synchronization channel was recorded onto one audio channel, and the FM signal from the EKG channel was recorded onto the second audio channel for use as an audible cardiac beeper.

Precautions were taken to maximize the limited resolution of standard video signals and to maintain a consistent format during presentation. First, the ink pens of the polygraph recorder were modified to produce a wider than normal ink tracing. Based on video resolution tests using the modified polygraph recorder, the three or four most important channels were recorded onto videotape. Second, the video recording format was designed so that the text screens to be overlaid from the computer during presentation would be shifted down, thus reserving as much of the screen as possible for the limited-resolution video images. Third, during conversion to video, a test screen from the computer was overlaid onto the video image to aid in adjusting the specially designed camera mount. This maintained consistent formatting with a designated space on all recordings reserved for overlay of computer generated information during presentation.

With the aid of the audio synchronization channel, the video recordings of the polygraph recorder data were combined with the original video recordings of the experimental procedures using a 3/4 inch A/B roll editing system, (Crawford Post Productions, Inc.). The resulting second-generation tapes thus depicted the polygraph recordings with a window insert illustrating the procedures, such as drug injections or nerve stimulations.

The second-generation videotapes were edited in house using a 3/4 inch control-track editing system with servo frame locking (Panasonic NV-9600) to produce the third-generation 3/4 inch edited master videotape. The edited master contained approximately 12 minutes for the experimental preparation and 15 minutes for the polygraph recordings with blank sections between each polygraph segment for later addition of still-frames.

The edited master videotape was played into a real-time image capture system (TARGA 32), and the desired ending frame for each recording was captured in digital form. Three modified versions of the ending frame of each recording were prepared using a computer graphics program (Lumena 32). The first version added calibration marks to each channel, and the second added calibration numbers. The third version added channel labels and a figure title. Using a computer controlled editing controller (BCD Associates VIPC with the Panasonic NV-9600 editor), the three versions were then recorded as successive still-frames back onto the correct location of the edited master tape. This made it possible during presentation to end a recording either on an original video frame or on a video frame with calibration marks or calibration marks plus calibration numbers. The third version with channel titles and a figure title could be used for still-frames. This process was done to preserve flexibility in the final authoring and presentation.

Additional still-frames selected from other recordings were added in the blank spaces that had been left between each polygraph recording. Finally, other stillframes and animations were edited onto the master tape. The animations were created using an object-oriented graphics package (Zenographics EGO). A single image showing each step in the animation was first drawn. Portions of the combined image were then selected and deleted to leave only the portion desired for a particular frame. The images were processed through a high resolution system (General Parametrics VideoShow), and the resulting frames were edited to videotape using the single frame computer controller. After completion of the still-frame editing, the time code channel was erased and replaced with audio narration. The third-generation edited master was bumped up to one inch (Auburn University Division of Educational Television) for videodisc mastering (3M, Inc.).

To eliminate the requirement of writing specific computer programs for the presentation, we developed a new authoring program suitable for our needs.[5] This program translates material from an outline or word processing format into Microsoft QuickBasic computer source code. The automatically generated source code is then compiled to produce stand-alone executable programs that can be called directly from the computer operating system. This approach lets the author concentrate on the subject matter, not computer programming details. This also makes it possible for other educators to modify the lessons or merge them into other computer simulations.

DISCUSSION

Videodiscs are normally developed using expensive broadcast quality video equipment, and educators may have the impression that equipment available in most media centers is not suitable for such efforts. In this experiment the only specially purchased equipment was the TARGA image capturing system and software. All other equipment was already available in our Learning Resources Center. Our experience has indicated that acceptable quality can be achieved with industrial grade equipment available in many media centers. But we must use careful planning in the selection of appropriate material, and attention to detail is essential in all stages from original experimental design to post-production.

Some rules of thumb we used to maximize the quality with our available equipment are summarized below.

- Separate the video and physiological data recording. It is almost impossible in a single experiment to obtain acceptable video and polygraph recordings simultaneously.

- Conduct tests of the polygraph recorder resolution after conversion to video, and use the minimum possible number of channels.

- Plan ahead for consistent locations of overlaid computer text onto the video, and reserve as much of the screen as possible for the video data.

- Use outside commercial video production where needed. In our case, this included a single editing session for A/B roll editing and special effects to combine the video of the procedures with the video of the data at a cost of approximately $1,200.

- Avoid placing text or graphics onto the video. Instead, add these directly from the computer during presentation, which gives much greater resolution and preserves the ability to change the text. In our case, we compromised by adding text to single frames of video at the end of each segment, which made the programming much simpler, but still preserved our options to make changes.

- Use a program authoring approach that can adapt to a variety of hardware, and make it possible for other instructors to modify the lessons for their individual needs. In our case, we developed an authoring program that creates the lessons as standard source code that can be modified directly for minor changes or by using the authoring program for major changes.

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- Make frequent high-quality dubs of the edited master in case of accident. In our case the dubs never had to be used.

The limitations of the video production and editing equipment were accounted for in the selection of materials, with the result that the video quality was sufficient for the application. Thus, in our judgement, video equipment available to most of us can be used for presentation of some types of material. Other types of material, such as presentation of histopathological slides or radiographs might demand greater quality that could only be achieved by contract to commercial video developers.

Although most of the video equipment used in this project is relatively inexpensive and readily available, one should not assume that the entire process is inexpensive. To the contrary, it is very expensive — primarily in the form of personnel time. This leads to our major point: Application of this technology will require us to develop ways to cooperate in the development and sharing of the resulting lessons. We will have to give careful attention to the applicability of our lessons to other schools and even to other disciplines if we hope to achieve the economies of scale that could bring the costs per user down to feasible levels.

As an example, suppose the total developmental cost of the cardiovascular lab were $100,000 (not an unreasonable estimate). Use of the lesson by 100 students in one school would cost $1000 per student. Extending its use to 1000 students would bring the user cost down to approximately $100. 10,000 student uses would be required to bring the cost down to a more reasonable $10 per student.

The point is that we must give up our old practices in which educators in many schools produced slightly different versions of essentially the same videotapes. Instead, we must be careful to design videodisc lessons for many schools and disciplines. Furthermore, we must be willing to use lessons that we might have done differently, but that are nevertheless acceptable.

If we hope to encourage the development of these types of materials, we must also develop means to encourage faculty – especially the younger and more creative faculty – to participate. The existing academic reward system in most universities favors traditional bench research that can be evaluated by refereed research publications. Developing interactive video lessons (or other new teaching methods) does not lead towards traditional research publications. Peer review of instructional developments is lacking, and there is no assurance that it would be used even if available. Unless these problems are addressed, we will remain dependent on older educators who have already reached the top academic ranks and can ignore the academic reward system.

We must also give some attention to hardware compatibility. Hardware systems are variable, and lessons written for one system may not work on a different system. Educators have little incentive to create lessons that cannot be used at most schools, and schools have little incentive to purchase hardware until numerous lessons are available. These interrelated problems are improving as some defacto standards begin to appear. The hardware costs are decreasing, and the cost per user will decrease as more lessons become available.

Efforts are underway to cooperate in developing interactive video and related technologies and bring the costs down to more manageable levels. In 1987 a group of veterinary medical educators from seven schools joined together to form CONVINCE, a consortium dedicated to bringing this technology into actual use in formal veterinary education and continuing education. Educators in medical schools have formed similar cooperative ventures.

The future is bright for this and other innovations in health science education, but cooperation will be the watchword for success. We cannot let future educators accuse us of developing merely another generation of expensive toys. Instead, we must work together to apply technology towards solving the severe problems that face health science education.

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The cardiovascular lab simulation is available for purchase or on loan to educators who wish to experiment with its use with students. The authoring program used to develop the lessons is also available on loan so that educators may modify the lessons or merge them into other computer simulations. The executable lessons may be configured to run on a variety of hardware systems, including IBM InfoWindows or the Matrox VGO-AT video overlay board with a Pioneer LD-V4200 or LD-V6000 series videodisc player.

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The Bulletin Board is published periodically to inform readers of upcoming meetings of interest. If you know of meetings, symposia, continuing education courses, etc, of interest to life science educators, and they do not appear in The Bulletin Board, please let us know. Send pertinent information to: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187, or let us know via BITnet. NRCLSE's BITnet address is: MODELL@UWALOCKE

DECEMBER 11-21, 1989. Fifth Annual International Symposium on World Trends in Science and Technology Education. Makati, The Philippines.

Contact:

Adoracion D. Ambrosio
Phillipine Science High School
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The Phillipines

JANUARY 19-20, 1990. Association of Biologists for Computing, Winter Meeting. Sonoma State University, Rohnert Park, CA.

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Bob Sherman
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Rohnert Park, CA 94928
(707) 664-2114

JANUARY 25-27, 1990. Interactive Hypermedia Teaching Applications Training Workshop. Thousand Oaks, CA.

Contact:

Michael Kolitsky
Optical Data Design Center
California Luthern College
Thousand Oaks, CA 91360
(805) 493-3515

JANUARY 30 - FEBRUARY 2, 1990. Tenth Florida Educational Technology Conference. Daytona Beach, FL.

Contact:

Office of Educational Technology
FETC
Florida Education Center
325 W. Gaines St., B1-54
Tallahassee, FL 32399
(904) 488-0980

JANUARY 31 - FEBRUARY 4, 1990. 1990 National Convention of the Association for Educational Communications & Technology (AECT). Anaheim, CA.

Contact:

AECT
1990 National Convention
1126 Sixteenth St., N.W.
Washington, D.C. 20036
(202) 466-4780

FEBRUARY 21-23, 1990. Eighth Conference on Interactive Instruction Delivery.

and

Fifth Conference on Learning Technology in the Health Care Sciences. Kissimmee, FL.

Contact:

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FEBRUARY 22-23, 1990. Ninth Annual Indiana Computer Educators (ICE) Conference. Indianapolis, IN.

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Kim Brown
ICE '90 Conference
1 S.E. Ninth St.
Evansville, IN 47708

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(812) 426-5027

MARCH 19-21, 1990. Tenth Annual Microcomputer in Education Conference *and* The Technology and The Funding to Acquire It mini-conference. Tempe, AZ.

Contact:

Janie Wilson
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Arizona State University
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Tempe, AZ 85287-0908
(602) 965-7363

MARCH 29 - APRIL 1, 1990. 27th National Conference on Technical Education. Oklahoma City, OK.

Contact:

Betty Krump
Executive Director for American Technical Education Association, Inc.
(701) 671-2240

JUNE 20-23, 1990. First Annual Educational and Research Conference of the American Medical Informatics Association. Snowbird, UT.

Contact:

Michael Hamm
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1101 Connecticut Avenue, N.W.
Suite 700
Washington, D.C. 20036
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AUGUST 22-24, 1990. Sixth Annual Conference on Applications of Artificial Intelligence and CD-ROM in Education and Training.

and

12th Annual Conference on Interactive Videodisc in Educationa and Training.

and

6th Annual Conference on Development of Interactive Instruction Materials. Washington, D.C.

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Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 89

SUMMARY OF LIQUID CRYSTAL DISPLAY PROJECTION PAD VENDORS 91

LETTER TO THE EDITOR: EDUCOM/NCRIPTAL HIGHER EDUCATION SOFTWARE AWARDS PROGRAM 92

MAKING "UNSUITABLE" SOFTWARE SUITABLE 93
Harold I. Modell

INDEX FOR VOLUME 6 95

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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SUMMARY OF LIQUID CRYSTAL DISPLAY PROJECTION PAD VENDORS

Liquid crystal display (LCD) projection pads have improved considerably since their introduction several years ago. In 1987, Stull and Knoll surveyed this market and listed 5 distributers of LCD projection panels (see CLSE 4:76-77, 1987). The number of distributors has since more than doubled. Resolution has improved; units are available for a broader range of graphic output modes (CGA, EGA, VGA, Macintosh); and some units offer color display. The following list of vendors has been compiled to help CLSE readers identify sources of LCD projection pads that will meet their projection requirements.

Apollo Audio-Visual
60 Trade Zone Court
Ronkonkoma, NY 11779
(516) 467-8033

ASK LCD Inc.
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LETTER TO THE EDITOR: EDUCOM/NCRIPTAL HIGHER EDUCATION SOFTWARE AWARDS PROGRAM

The EDUCOM/NCRIPTAL Higher Education Software Awards program is now accepting entries for its 1990 competition. Once again, we will identify and reward outstanding software packages and effective curricular implementations of computers at the college level.

This year, the competition has been expanded to include three professional disciplines: law, accounting, and undergraduate engineering, as well as the undergraduate liberal arts [including biology], previously included. Special encouragement is given to curriculum innovations for projects that address problems in writing, laboratory sciences, and underprepared students. *The deadline for completed applications is March 2, 1990.*

Now in its fourth year, the program is achieving national as well as ever-increasing international recognition, made possible by the sponsorship of foundations and hardware and software companies, such as AT&T, Apple Computer, Inc., Bell Atlantic, Claris Corporation, IBM Corporation, Microsoft Corporation, NeXT, Inc., National Center for Automated Information

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Software Competition

New Product Awards

For faculty and software developers who have created exemplary academic software in the following areas:

- **Liberal Arts** (Natural Sciences, Social Sciences, Humanities, Foreign Languages, and Mathematics)
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For faculty who use software (usually developed by others) innovatively in undergraduate courses to improve:

- **Writing Skills**
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- **Performance of Underprepared Students**

Best and Distinguished awards are given in both categories. Winners receive monetary awards and a trophy.

EDUCOM and the National Center for Research to Improve Postsecondary Teaching and Learning (NCRIPTAL) co-sponsor this annual competition to promote the effective use of computers in the college classroom. Academic associations provide judges for content accuracy and curriculum design. AT&T, Apple, IBM, Microsoft, NCAIR, NeXT, and Sun Microsystems provide additional support for the competition.

For information and entry forms, write:

Etta Vinik
Awards Program
NCRIPTAL, 2400 SEB
University of Michigan
Ann Arbor, MI 48109-1259

Deadline for entries is March 2, 1990.

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Retrieval, and Sun Microsystems and the numerous academic associations who not only assist us with publicity, but also provide credibility by identifying prominent scholars to serve as reviewers.

Last year, we reviewed 200 entries and identified 22 as Distinguished; fourteen of these were selected as Best in various categories. The Best Award winners each received a substantial monetary award and a trophy. The Distinguished Award winners received a smaller monetary award and a plaque. We are particularly pleased that five of the awards went to faculty members for their effective use of computers in the curriculum.

We are very excited about the potential contribution that computers can make to higher education and about the quality of software we reviewed in 1989. We expect to see even higher quality software and curricular innovations in 1990.

Robert B. Kozma
Program Director
NCRIPTAL

Steven W. Gilbert
Vice President
EDUCOM

MAKING "UNSUITABLE" SOFTWARE SUITABLE

Harold I. Modell
National Resource for Computers in Life Science Education, Seattle, Washington

Although the base of available software for life science education continues to grow, the complaint that a critical mass of high quality software does not yet exist continues to be voiced by a large number of life science educators. While this complaint is undoubtedly valid, it may be time to reevaluate the criteria by which software is deemed "unsuitable" in a variety of curricula.

Most available software has been designed to fill a tutorial role in an independent study setting, and when educators view this software, they usually limit their evaluation to this setting. However, the growing number of low cost devices for group presentation of computer output has increased the feasibility of using the computer as an adjunct to traditional classroom activities.

The question then becomes, "Can software judged as 'unsuitable' for student use in an independent study environment be used to enhance classroom teaching?" The answer is that, in some cases, it can.

WHAT IS "UNSUITABLE" SOFTWARE?

Negative comments about software generally fall into several broad categories, the input/output schemes are cumbersome, the output screens can lead to misunderstandings, or the content is "wrong."

Software in which the input/output formats make it difficult to interact with the program are not viable candidates for use in a classroom setting. The goal of using software in the classroom is to use the program to enhance the learning environment. Any potential for having the technology become the focus of attention detracts from this environment,[2] and the probability of encountering computer oriented error messages or exhibiting computer directed hostility by the user is greater with programs whose input/output schemes are cumbersome.

Programs whose output screens can lead to misunderstandings in an independent study setting may, however, be used to great advantage in a classroom setting. For example, a program dealing with osmotic pressure that has been commercially available for several years simulates the classic thistle tube experiment. The graphics display shows a thistle tube with a semipermeable membrane inverted in a beaker. At the beginning of the simulation, solute is shown in the thistle tube, and, as the simulation proceeds, solvent moves up in the thistle tube until the osmotic pressure is balanced by the hydrostatic pressure in the tube. The limitation of the output is that the level of liquid in the beaker remains constant throughout the experiment. The representation of the thistle tube is large enough and the vessel small enough so that the fluid level in the vessel should drop during the experiment. This oversight suggests that mass is not conserved in this system.

The limitation of this particular simulation can be used in a classroom discussion, presumably directed toward osmotic pressure, to reinforce the scientific method, help students understand the limitations of the modeling process, and impress upon students the need for questioning assumptions. Before the simulation is run, students would be asked to predict what will happen during the experiment. This portion of the discussion would include the tube as well as the reservoir. The simulation would be run, and the students would

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be asked to discuss how the model differed from their predictions. The next step is to decide whether the problem is with the model or the prediction, and possible actual experiments could be discussed that would answer this question.

PROGRAMS WHOSE CONTENT IS "WRONG"

Perhaps the best examples of this type of program are some of the clinical simulations available for nursing and medical students. These programs generally present a clinical situation and ask the student to make judgements relative to the diagnosis and treatment of the patient.

These programs, of course, reinforce the philosophy and procedures in vogue at the particular institution where the software was developed. Faculty at other institutions with differing philosophies and approaches to diagnosis and treatment view these programs as unacceptable because the program gives the student the "wrong" information. For independent study, these faculty may be entirely correct. However, if the software is used in a classroom setting, it can be extremely helpful.

Faculty tend to ignore the fact that these particular student populations usually continue their training at other institutions. It is not unreasonable for medical students to seek residencies at institutions whose philosophy and approach to clinical medicine is quite different from that taught during their initial medical training.

The clinical simulation with the "wrong" approach is an excellent vehicle for reinforcing the "correct" approach and helping students to understand that different clinicians interpret currently available data differently. These simulations may also be used to reinforce a collegial attitude among students and faculty.[1]

In this case, the class and instructor would go through the simulation together. Where the author's approach to the situation is different from the instructor's, a discussion examining the relative merits of the two approaches would ensue. In this environment, the students benefit both from the instructor's and the author's experience.

CONCLUSION

A relatively large volume of software is currently available that suffers from a variety of shortcomings making that software unsuitable for use in independent study environments. However, these shortcomings, when viewed from a group discussion perspective, can not only make this "unsuitable" software suitable, they may, in fact, turn this software into a valuable adjunct to classroom discussion.

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COMPUTERS IN LIFE SCIENCE EDUCATION, VOLUME 6 INDEX

anatomy software, 2:11
annual report, NRCLSE, 1:3-4

biochemistry software, 2:11-12
biology software, 2:12
botany software, 2:12-13
Beckett SD, 11:81-86
Branch CE, 11:81-86
Breckler JL, 7:49-50
bulletin board, 1:4-5, 11:86-87

Can you help? 4:28, 12:91
clinical medicine software, 2:13
CLSE colleague directory 5:33-38, 6:44-47, 7:51-55
Course of Action 6:41-43
cytology software, 2:14

ecology software, 2:14
EDUCOM, 12:92-93
error handling, 1:2
evaluation
    of software, 1:1-3, 12:92-93
    NRCLSE software form, 4:29-31
evolution software, 2:14
Extend, 8:57-63

Fawver AL, 11:81-86
forestry software, 2:14
Frkonja J, 9:65-72

genetics software, 3:18-19
Gilber SW, 12:92-93
Guide, 9:65-72

Heath RB, 6:41-43
Hypercard, 9:65-72
Hypermedia, 2:9-11, 9:65-72
Hypertext, 2:9-11, 9:65-72, 10:73-79

interactive videodisc, 11:81-86

Kearsley G, 1:1-3
Keeping Abreast of the Literature, 3:17-18, 6:43
Keriaty L, 2:9-11
Kozma RB, 12:92-93

laboratories, physiology, 7:49-50, 11:81-86
LabView 8:57-63
LCD projection pads, 12:91
Lewis MM, 11:81-86
Liquid Crystal Display projection pads, 12:91
Linkway, 2:9-11, 9:65-72, 10:73-79
literature, keeping abreast of, 3:17-18, 6:43, 10:79

Macintosh 6:41-43
Mandel JE, 8:57-63
microbiology software, 3:19
modeling, 8:57-63
Modell HI, 10:73-79, 12:93-94

neuroscience software, 3:19
NCRIPTAL, 12:92-93
NRCLSE
    annual report, 1:3-4
    peer critique mechanism, 1:4
    questionnaire, 1:6-7, 5:39
    software evaluation form, 3:29-31
    software distribution, 1:4
nursing software, 3:19

pharmacology software, 3:19-20
physiology software, 3:20-22, 11:81-86
projection
    LCD, 12:91
    vendors, 12:91

response analysis, 1:2
Robertson BT, 11:81-86

tutorial, 6:41-43, 10:73-79

simulation, 8:57-63
Slimp M, 11:81-86
software
    anatomy, 2:11
    authoring, 6:41-43, 9:65-72
    awards program, 12:92-93
    biochemistry, 2:11-12
    biology, 2:12
    botany, 2:12-13
    clinical medicine, 2:13-14
    cytology, 2:14
    ecoloty, 2:14
    evaluation, 1:1-3
    evolution, 2:14
    Extend, 8:57-63
    forestry, 2:14
    genetics, 3:18-19
    Guide, 9:65-72
    Hypercard, 9:65-72
    Hypertext, 2:9-11
    IBM compatible, 2:9-11, 9:65-72
    LabView, 8:57-63
    Linkway, 2:9-11, 10:73-79
    Macintosh 6:41-43, 8:57-63, 9:65-72
    microbiology, 3:19
    neuroscience, 3:19
    NRCLSE evaluation form, 4:29-31
    nursing, 3:19
    pharmacology, 3:19-20
    physiology, 3:20-22, 10:73-79
    population dynamics, 4:25-26
    quality control, 1:2-3
    simulation, 8:57-63
    sources, 2:15
    STELLA, 8:57-63
    substance abuse, 4:26
    suitable, 12:93-94
    unsuitable, 12:93-94
    user control, 1:2
    vendors, 2:15, 3:22-23, 4:27-28
    zoology, 4:26
STELLA, 8:57-63

videodisc, 11:81-86

Where's the Softwhere? 2:11-15, 3:18-23, 4:25-28
workstations 7:49-50
    applications, 7:50
    guidelines, 7:49-50

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

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Articles submitted for publication should not exceed 2000 words and should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

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COMPUTERS IN LIFE SCIENCE EDUCATION

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CONTENTS

THE COMPUTER AS A TEACHING TOOL – HOW FAR HAVE WE COME? WHERE ARE WE GOING? 1
Harold I. Modell

NRCLSE ANNUAL REPORT FOR 1989 5

NRCLSE QUESTIONNAIRE 7

THE COMPUTER AS A TEACHING TOOL – HOW FAR HAVE WE COME? WHERE ARE WE GOING?

Harold I. Modell
National Resource for Computers in Life Science Education, Seattle, Washington

It seems appropriate when making a transition between decades to reflect on the progress that has been made during the decade just ending and project what might lie ahead in the new decade.

The progress made in the decade just ending has been considerable. The topics covered by articles appearing in Computers in Life Science Education reflect this progress. As we entered the 1980s, use of the computer as an instructional tool was largely limited to environments that supported mainframe computers or minicomputers offering timeshare capabilities. Terminals were generally restricted to text output and were reserved for independent study environments. The majority of applications were tutorial and followed the traditional Computer-Assisted Instruction (CAI) question and answer format. The introduction of the microcomputer, however, changed the way in which educators viewed the utility of computer technology.

MOVING TECHNOLOGY TO THE CLASSROOM

The technology was no longer restricted to rooms that provided "hard-wired" or modem connections between terminal and computer. The microcomputers could easily be moved to where the students were. Furthermore, these machines could be easily programed to in-

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clude graphic displays and animations. In addition to pursuing the traditional applications of computer-assisted instruction,[23,25,48,51,58,59] educators moved the technology into the classroom. Applications ranged from using simulations in small group[33,52] and lecture[40] settings to foster active learning to using the computer as a "slide projector" to incorporate animation and provide a "building block" approach to developing concepts with students.[18,34] The technology also provided a communication vehicle in the form of an electronic blackboard that could be used during teleconferencing of instructors and students who were separated geographically.[26] Introduction of video projection devices[54,56] provided large screen displays of the computer output so that the class and instructor could work together while viewing the same screen.

The microcomputer also made an impact in enhancing the active learning experience of the student laboratory.[3,7] The technology provided a relatively inexpensive means of acquiring data[2,9,12,30,49] as well as a tool for analyzing data within the time frame of the student laboratory period.[20] Furthermore, by using simulations, students could perform "experiments" that were previously not possible either because of cost of necessary equipment, time available, or risk to the student.[11,13,21,24,57]

QUESTIONS TO BE ANSWERED

Implementation of this technology raised new questions related to delivery of instruction. Is this technology cost effective?[32] Are programs intended for use in one educational environment useful in other environments?[34,37,41] What design criteria should be considered when using graphics in instructional software?[8] What factors should be considered when designing simulations?[38,42] What constitutes "good" educational software?[27] How does one evaluate software?[53,55]

The question of evaluation is a significant issue that has yet to be resolved. NRCLSE addressed this issue[43,39] and established a peer critique mechanism for software review.[44] EDUCOM and NCRIPTAL established a national competition as a mechanism for evaluating software and curriculum innovations incorporating computer applications.[31] However, many authors have yet to avail themselves of these mechanisms, and, as a result, much of the available software has not been subjected to a rigorous evaluation process.

INTERACTIVE VIDEO

Although optical videodisc technology was available at the beginning of the decade, the cost of mastering videodiscs and software support for this medium had not developed to the point where general application of this methodology was practical. By the mid-1980s, however, significant improvements had been made in both areas, and interactive video emerged as a viable mode of delivering instruction where a significant portion of the content was visually oriented.[5,6,14,22,47,61] Interactive video did not require images to be stored on a videodisc, however. Some educators used existing images stored on videotape and were able to couple these images with computer based interactive programs to produce acceptable interactive video instruction.[1,46] Perhaps one of the more intriguing applications of interactive videodisc technology was a series of case studies designed for use in a group setting that incorporated a voice-driven microprocessor. In this system, the user interacts with the program through a series of voice commands.[17]

SOFTWARE DEVELOPMENTS

The tools available for faculty wanting to develop educational software improved significantly during the 1980s. Early in the decade, authoring software was aimed helping educators develop programs that adhered to the tradition CAI tutorial formats.[16,35] Many of these systems did not include arithmetic capabilities necessary for supporting mathematical models. If faculty wished to develop such simulations, it was necessary for them to know how to program using a general purpose computer language (eg, BASIC, FORTRAN, PASCAL).

The introduction of mouse technology and the user interface strategy at the heart of the Macintosh computer fostered development of new authoring tools that provided faculty not familiar with programming techniques the opportunity to author educational software. Some packages offered digitized sound and sophisticated graphics capabilities that allowed movie-like animation.[19] Others, not specifically aimed at, but certainly applicable in the educational arena, were designed to provide a simulation environment to non-programmers.[10,29,36]

Perhaps the single software advancement that has made the biggest impact in educational computing is the implementation of the hypertext concept.[28,60] The crux of the hypertext concept is the idea that users of a database should be able to move through that database in a nonsequential fashion. This has led to computerized versions of syllabi and other textual material with links to associated material so that the student need only choose highlighted words to retrieve related information. The graphics capabilities of this software and the option of accessing information on other media (eg, videodisc, CD-ROM) has extended this organization mode to a wide variety of options.[15] The software also provides authors with a "friendly" development environment in which a variety of interactive modes may be used for tutorial applications.[45]

PROJECTIONS FOR THE 1990s

The hardware and software advances made in the 1980s offer considerable potential for the 1990s. New user interface modalities (eg, the mouse and touch screen), easier graphics generation (eg, "draw" and "paint" programs), the ability to incorporate multimedia resources

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through hypermedia or other applications, and the growing resources available to generate or access visual and audio data have opened new vistas for faculty who are interested in developing instructional materials.

Incorporating these resources with technology designed to foster communication between students and the instructor[50] can result in an active learning classroom environment in which teachers can diagnose and address the progress of individual students during each classroom period.

Hence, the 1990s may see the emergence of classrooms in which instructors have ready access a broad scope of visual, audio, and textual databases with which to encourage active learning experiences within a group or independent study setting.

Real progress will depend, however, on several related factors that are independent of hardware and system software developments. These factors include commitment by faculty to develop high quality, versatile materials, establishing faculty rewards for such efforts, and identifying funding sources to support such efforts.

Developing creative, effective software requires a considerable time investment. If the past decade is any indication, faculty who have developed software have done so with a specific application in mind, usually directed toward a specific course and specific student population. They have not attempted to subject their software to rigorous peer evaluation, nor have they taken advantage of attempts to improve good communication channels to share development ideas and existing software. This has led to unnecessary duplication of software covering concepts in some areas and virtually no software in other, equally important, content areas within the same discipline. To be completely successful, a critical mass of high quality software covering all aspects of a given discipline must be available. This pool must contain software that is versatile enough to be used in different curricula and at different levels of sophistication. To reach this level, faculty must submit their software to peer evaluation, and they must establish collaborative efforts with colleagues so that the time invested may yield maximum benefit.

Peer critique and establishing collaborative efforts go hand-in-hand with restructuring faculty evaluation criteria. Currently, faculty involved in developing computer-based materials do not often receive rewards consistent with their time investment or the impact of their efforts on student learning. Consequently, faculty are not willing to undertake such projects. This situation must be remedied if significant progress is to be made. Part of the reason for the inequity in the reward structure may be that most of these efforts do not extend beyond a single institution. As a result, the body determining faculty rewards (eg, the Appointments and Promotions Committee) are unable to fully evaluate such contributions. If, however, results of peer critique of these efforts were available, and the efforts had a national focus, criteria similar to evaluation of scientific bench research could be applied.

Another criterion often used for faculty promotion is the level of external funding obtained for support of research and development efforts. This is a critical issue for the 1990s. In the past, funding agencies have not supported research and development efforts aimed at applying computer technology to life science education. A concerted effort must be made to help these agencies realize that funding research and development of technology-based applications to life science education is critical to progress in this area.

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NRCLSE ANNUAL REPORT FOR 1989

The overall purpose of NRCLSE is to cultivate collaborative efforts among faculty with expertise in using computers in life science education. The broad goal of the Resource is fourfold:

1) to educate faculty in effective uses of computers in the curriculum;
2) to promote research aimed at evaluating new applications of the computer to life science education;
3) to promote development of a critical mass of high quality, versatile software, and
4) to serve in a consultant capacity for life science faculty currently active or interested in becoming active in this area.

This year's activities continued our efforts to serve the life science community. A statement of NRCLSE's financial status is presented in Table 1.

Table 1. NRCLSE Financial Report for year ending December, 1989.

Fund Balance, December 31, 1988		**$13,702**
Revenues		
Cash donations	1,000	
Subscriptions/Reprints	5,540	
Software/Manual sales	2,882	
Total Revenues	9,422	
Expenses		
CLSE production	3,541	
Postage/Shipping	1,963	
Operating expenses supplies, phone, etc.	725	
Travel	591	
Equipment	1,124	
Total Expenses	7,944	
Increase in fund balance	1,478	
Fund balance, December 31, 1989		**$15,180**

GENERAL OVERVIEW OF ACTIVITIES

During 1989, NRCLSE moved its operation from the University of Washington to larger quarters. The new space arrangement has helped to improve the operation of the Resource by allowing consolidation of our computer, office, and newsletter/software warehousing capabilities into one location.

Publication of *Computers in Life Science Education* continued to be NRCLSE's primary activity in 1989. However, during the past year, we continued to provide information to colleagues throughout the world concerning use of computers in life science curricula, participate in national meetings, conduct demonstrations at several institutions, and distribute our Simulations in Physiology software. We have also embarked on a software development project utilizing the hypertext environment.

Computers in Life Science Education

Subscriptions to CLSE continue at the same level as in previous years, with about 30% of the subscriptions being held by libraries. About half of the subscribing institutions focus on undergraduate education, and about one fourth focus on medical education. The geographic distribution of subscribers continues to be broad. In addition to the U.S. and Canada, subscribers for 1989 included institutions in Denmark, the Federal Republic of Germany, France, Great Britain, Hungary, Israel, Japan, Norway, the Philippines, and Sweden.

Software distribution

In 1989, eighteen sets of our simulations were distributed to institutions in the U.S., Belgium, Italy, Scotland, and Sweden. Currently, over seventy-five institutions representing twelve countries on

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four continents have purchased one of the microcomputer versions of Simulations in Physiology - The Respiratory System.

Resource Information

During 1989, NRCLSE again responded to 50 requests for information concerning use of the computer as an educational tool. As in previous years, the geographic origin of the requests continues to reflect our goal of providing worldwide service. Requests in 1989 were received from fourteen countries in addition to the United States.

Presentations/Consultation

Dr. Modell served as the keynote speaker for a computer assisted teaching workshop sponsored by the International Foundation for Ethical Research (IFER) held in Denver in March, 1989. IFER, recognizing the need for use of live preparations in research and teaching, is concerned with the discovery, development and implementation of *viable, scientifically valid* alternatives to the use of live animals in research, testing, and teaching where such alternatives are feasible.

NRCLSE was instrumental in organizing a tutorial session entitled "Using the microcomputer in the classroom" that was co-sponsored by the Teaching of Physiology Section of the American Physiological Society and held on March 21, 1989 at the 73rd annual meeting of the Federation of American Societies for Experimental Biology (FASEB) held in New Orleans.

NRCLSE also visited four medical schools in 1989 to demonstrate the use of the computer to foster active learning in the classroom and discuss uses of computers in the basic science curriculum.

Peer critique of software

Our program for peer critique of software initiated in October, 1988 received a boost this year. The description of the program (see CLSE, October 1988) was reprinted this year in *Collegiate Microcomputer* (VII(2):181-183, 1989) and *Science Software* (5(3):211-213, 1989).

New software initiative

NRCLSE began work on a new software package this year. The package will use the hypertext environment to incorporate tutorial screens (see CLSE, October 1989) with the Simulations in Physiology models. The package will be intended to serve as resource material for classroom interaction and as a course in respiratory physiology concepts for independent study.

Special thanks

NRCLSE extends a very special "Thank you" to the following people, organizations, and institutions for their support in 1989.

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NATIONAL RESOURCE FOR COMPUTERS IN LIFE SCIENCE EDUCATION QUESTIONNAIRE

It is time once again to update our CLSE colleague directory. Please help ensure that we provide accurate information. Take a few minutes to complete the questionnaire below and return it to the following address:

Harold Modell, Ph.D.
NRCLSE
P.O. Box 51187
Seattle, Washington 98115

Name: ______________________________

Address: ______________________________

______________________________ State ________ Zip ____

Phone: ______________________________ BITNET: ______________________________

What content areas do you teach? ______________________________

What student population(s) do you serve? (Please check appropriate categories)

_____ Undergraduate _____ Graduate _____ Nursing _____ Medical

_____ Allied Health _____ Dental _____ Veterinary

_____ Other (please specify) ______________________________

Are you currently using the computer as an educational tool? ___ Yes ___ No

If yes:

How many years have you used the computer in this way? ________

What kind of equipment are you using?

Have you written any software for use in your teaching efforts? ____ Yes ___ No

What commercially available software have you found useful?

Would you be willing to help critique software for peers? ____ Yes ____ No

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

RESPONSIBILITY AND COPYRIGHT

Authors are responsible for accuracy of statements and opinions expressed in articles. All authors submitting manuscripts will be sent a copyright transfer form to complete. The completed form must be returned before the work will be published.

SUBSCRIPTION INFORMATION

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Address editorial correspondence to Harold I. Modell, PhD, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187. (BITNET MODELL@UWALOCKE)

POSTMASTER: Send address changes to *Computers in Life Science Education*, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

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CONTENTS

WHERE'S THE SOFTWARE - PART I 9

WHERE'S THE SOFTWARE? - PART 1

In the past, we have published lists of life science software sources and programs available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

The listings are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on page 15.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

ANATOMY

ANATOMY OF A FISH

Tutorial/game presenting information on the external, internal, and skeletal structures of a bony fish. Available for Apple II compatible equipment.

VENTURA EDUCATIONAL SYSTEMS

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment.

WILLIAMS & WILKINS

ANATOMY OF A SEA LAMPREY

Tutorial/game presenting information on the life cycle and anatomy of a sea lamprey. Available for Apple II compatible equipment.

VENTURA EDUCATIONAL SYSTEMS

BODY LANGUAGE I, II, III, IV

A series of drill and practice reviews of anatomical terms. Available for Apple II and IBM-PC compatible equipment.

EDUCATIONAL SOFTWARE PRODUCTS

GROSS ANATOMY TUTORIAL

Tutorial for gross anatomy review by region and for self-test in National Board format. Program available for Apple II equipment.

LIFE SCIENCE ASSOCIATES

HEART LAB

Animated graphics simulation of human heart. Program available for Apple II, TRS-80 Models I and III, PET, and Atari 800/800XL equipment.

EDUCATIONAL ACTIVITIES, INC.

HUMAN ANATOMY PICTURE FILE

Hi-Res diagrams of heart, brain, eye, ear, respiratory system, kidney, endo-

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crine system, neurons, circulatory system schematic, and digestive system. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

LOCOMOTION

Tutorial reviewing types and functions of bones and muscles. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOCHEMISTRY

ANIMATED PATHWAYS OF BIOCHEMISTRY

Simulation of molecules colliding and reacting. Available for IBM-PC compatible equipment. WILLIAMS & WILKINS

ANIMATIONS

Contains animations for demonstrating DNA structure and synthesis, RNA structure and synthesis, and protein synthesis. Program available for Apple II equipment. ALBION

BIOCHEMISTRY

Tutorial covering basic atomic structure, balancing equations, and properties of proteins and carbohydrates. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOCHEMISTRY EXAM/TUTORIAL

Covers basic fuel metabolism. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

CONCENTRATED CHEMICAL CONCEPTS: BIOLOGICAL CHEMIST

Drill and practice program covering an entire introductory course in organic chemistry for health science majors. WILEY PROFESSIONAL SOFTWARE

DNA STRUCTURE AND SYNTHESIS

Tutorial dealing with nucleotide structure and linkage between nucleotide, base complementarity and hydrogen bonding. Program available for Apple II equipment. EDUTECH, INC.

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //c (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

ENZKIN: Enzyme Kinetics

Simulation of enzyme-catalyzed reactions. Program available for Apple II equipment. CONDUIT

ENZLAB

Simulations for designing and carrying out enzyme kinetics experiments. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

ENZPACK

An enzyme kinetics teaching and calculation program. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

ENZYME ACTION

Tutorial on the basic nature and function of enzymes. Program available for Apple II equipment. BIOSOFT (UK)

ENZYME-SIMULATION, ENZYME ACTION

Simulation of enzyme action and the effects of inhibitors using acetylcholinesterase. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GENE MACHINE

Tutorial/Simulation dealing with DNA replication and protein synthesis. Program available for Apple II equipment. HRM SOFTWARE

MOLECULAR BIOLOGY SERIES

Programs demonstrating central processes of RNA and protein synthesis and DNA synthesis and repair. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

MOLGRAF

Molecular graphics package. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

THE NUCLEIC ACIDS

Tutorial/Simulation dealing with principal nucleotides and synthesis of RNA. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

PROTEIN SYNTHESIS

Tutorial dealing with the general structure of the amino acids and formation of peptide bonds. Program available for Apple II equipment. EDUTECH, INC.

RNA STRUCTURE AND SYNTHESIS

Tutorial extending the concept of hydrogen bonding between complementary bases to show the synthesis of RNA on the DNA template and the analogies in structure between DNA and RNA. Program available for Apple II equipment. EDU TECH, INC.

BIOLOGY

ADAPTION AND IDENTIFICATION

Tutorial covering animal adaptation to different environments and animal identification. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ANIMAL REPRODUCTION

Tutorial reviewing sperm development, egg and fertilized egg. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

ASEXUAL REPRODUCTION

Tutorial reviewing cell division. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOLOGY 1/BIOLOGY 2

Tutorials covering a wide range of topics in biology. Available for IBM- PC compatible equipment. INTELLECTUAL SOFTWARE

BIOLOGY COMPUTER STIMULATIONS

Tutorial covering various biological concepts and experimental areas including enzymes, photosynthesis, respiration, diffusion, meiosis, muscles, nerves, and genetics. Program available for Apple II and TRS-80 Models I and III equipment. LIFE SCIENCE ASSOCIATES

BIOLOGY DISSECTION FROG

Dissection guide that teaches students how to dissect a frog. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY LAB DISSECTIONS

Seven dissection guides teach students about seven different animals: Frog, Earthworm, Grasshopper, Crayfish, Starfish, Clam and Perch. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY SIMULATIONS PACKAGE III

Three collections of simulations covering aspects of genetics, natural selection, and predator-prey interaction. Available for Apple //c (enhanced) equipment. ALBION

CREATE A TEST/CREATE A TEST QUESTION FILES-BIOLOGY

Test creation program and 4800 question bank in biology. Available for Commodore 64, Apple II and IBM-PC compatible equipment. CROSS EDUCATIONAL SOFTWARE

DIFFUSION AND ACTIVE TRANSPORT

Tutorial covering diffusion, osmosis,

and active transport in biological systems. Program available for Apple II equipment. SIMPAC EDUCATIONAL SYSTEMS

ENERGETICS AND METABOLISM, GARDEN OF BIOLOGY: VOLUME I

Data base illustrating reactions of metabolism and interactions between the several metabolic compartments of a cell. Program available for Macintosh equipment. KINKO'S

EVOLUTION, GARDEN OF BIOLOGY: VOLUME 2

Data base illustrating relations among organisms of many kinds, emphasizing the history and mechanics of their evolutionary change. Program available for Macintosh equipment. KINKO'S

FASCINATING STORY OF CELL GROWTH

Tutorial covers surface area/cell volume, experimenting with cell size, chromosomes in cell division and stages of mitosis. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HOW'S AND WHY'S OF MIGRATING MOLECULES

Tutorial covering transport through a membrane, osmosis and diffusion. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HUNTINGTON I SIM PROG - BIOLOGY

Seven simulations for use in introductory level biology courses. Available for DEC equipment. HUNTINGTON COMPUTER PROJECT

KNOWLEDGE MASTER - BIOLOGY 2

Test-item database for test generation. Content covers coelenterates, arthropods, insects, fish, amphibians, and reptiles. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

KNOWLEDGE MASTER - BIOLOGY 3

Test-item database for test generation. Content covers birds, mammals, primates, protists, bacteria and taxonomic zoology. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

MARINE INVERTEBRATES

Tutorial covering animals from the Phylums Porifera, Mollusca, Coelenterata, and Echinodermata. Avaialable for Apple II equipment. VENTURA EDUCATIONAL SYSTEMS

OSMO- OSMOSIS IN RED BLOOD CELLS

Simulation of red blood cells in hypertonic, hypotonic, and isotonic solutions. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

OSMOSIS AND DIFFUSION

Tutorial/Simulation covering effects of temperature, concentration, solubility, molecule size and charge, and membrane pore size on flow of matter across semi-permeable membranes. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

OSMOTIC PRESSURE

Simulation of thistle tube experiments and animation of a molecular model for osmosis. Program available for Apple II equipment. CONDUIT

PASSIVE TRANSPORT

Tutorial-simulation covering diffusion and osmosis. Program for MS-DOS compatible equipment. CLASSROOM CONSORTIA MEDIA, INC.

PLANT AND ANIMAL CELLS

Tutorial covering the general structure of plant cells, photosynthesis, the general stucture of animal cells, and mitosis. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

SIMULATION OF HEMOGLOBIN FUNCTION

Simulations of hemoglobin and myoglobin functions. Program for Apple II equipment. QUEUE, INC.

THE INSECT WORLD

Simulation/tutorial covering insect types, body parts, and survival. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

BOTANY

ALGAL GROWTH

Simulation of the effects of eight variables on growth of algae. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

BIOLOGY FRUIT KEY

Identifies 125 trees and shrubs. Program available for Atari 400/800 equipment. DYNACOMP, INC.

COMPETE:Plant competition

Simulation of experiments involving interaction between flowering plants. Program available for Apple II equipment. CONDUIT

EARLY ANGIOSPERMS: A FOSSIL VIEW

Tutorial utilizing the fossil record to explain the development of flowering plants. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

EXPLORING THAT AMAZING FOOD FACTORY, THE LEAF

Tutorial covers transport in the leaf, structure of the leaf and stomate action in gas exchange. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

FAMILY IDENTIFICATION

Data retrieval program to review the characteristics of 74 North American flowering plant families. Program available for Apple II equipment. CONDUIT

HOW PLANTS GROW: THE INSIDE STORY

Tutorial covers growth of the plant, stem cross section, terminal bud and plant hormones. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

LEAF: STRUCTURE AND FUNCTION

Tutorial-simulation covering the anatomy and physiology of the leaf with respect to its role as the "chemical factory" of the plant. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PHOTOSYNTHESIS AND LIGHT ENERGY

Simulation focuses on characteristics of light and its role as an energy source. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PHOTOSYNTHESIS AND RESPIRATION

Demonstration and simulations focusing with light and dark reactions of photosynthesis, respiration, and ATP cycle. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

PHOTOSYNTHESIS & TRANSPORT

Tutorial dealing with photosynthesis and transport in plants. Program available for Apple II and TRS-80 Model III

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equipment. J & S SOFTWARE

PHOTOSYNTHESIS: UNLOCKING THE POWER OF THE SUN

Tutorial includes light as energy, light characteristics, wave length of light used by chromoplasts, variables and controls. Available for IBM- PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

PLANT ANATOMY PICTURE FILE

Hi-Res diagrams of roots, stem cross-section, leaf cross-section, photosynthesis, flowers, seeds, and germination. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

PLANT CELL CYCLE

Hypercard stack illustrating plant cell division. Available for Macintosh equipment. KINKO'S

PLANT GROWTH

Tutorial-simulation covering physiology of growth beginning with the seed. Covers hormone control, feedback mechanisms, transport, and differentiation. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PLANT PAINT

A set of 36 graphics images illustrating concepts in plant biology. Available for Macintosh equipment. KINKO'S

PLANT-PLANT GROWTH SIMULATION

Simulation of the effects of light intensity and duration on growth and development of green plants. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

REPRODUCTION IN PLANTS

Tutorial reviewing asexual and sexual reproduction in plants. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

SEXUAL REPRODUCTION IN PLANTS

Tutorial covering plant reproduction including meiosis, gamete formation, reproduction cycles, and alternation of generations. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

SOLAR FOOD

Tutorial/Simulation dealing with photosynthesis. Program available for Apple II equipment. HRM SOFTWARE

THE PLANT - NATURE'S FOOD FACTORY

Tutorial/simulation covering flowers, leaves, stems, roots, and cells. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

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Simulated patients with various cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

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Tutorial dealing with all major cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

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Tutorial dealing with the interpretation of arterial blood gases. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

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Eight simulations of clinical syndromes. Program available for Apple II equipment. BIOSOFT (UK)

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Test proficiency in the interpretation of blood counts. Available for IBM- PC compatible equipment. LEA & FEBIGER

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Study/review package dealing with various aspects of cardiovascular disease. Available for Apple II and IBM-PC compatible equipment. UMKC SOFTWARE SERIES

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Patient management problems dealing with chest pain. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

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Self-assessment package covering internal medicine, ob/gyn, pediatrics, preventive medicine and public health, psychiatry, and surgery. Available for Apple II and IBM-PC compatible equipment. UMKC SOFTWARE SERIES

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Tutorial covering basic math skills and drug dosage calculations. Available for Apple II compatible equipment. W.B. SAUNDERS CO.

DRUG INTERACTIONS

Computer tool providing access to clinically significant interactions between 600 generic and 1,400 brand-name drugs. Available for IBM-PC compatible equipment. W.B. SAUNDERS CO.

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

GAS MAN

Simulation of uptake and distribution of inhalation anesthetics in a 70 kg subject. Available for Apple II compatible equipment. MEDMAN SIMULATIONS

GASMAN

Simulation dealing with the principles of inhalation gas uptake. Available for Apple II compatible equipment. ADDISON-WESLEY PUBLISHING CO.

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Simulation of 6 cases providing practice and experience in diagnostic reasoning skills by demonstrating the needs of patients and the effects of nursing intervention. Available for Apple II and IBM-PC compatible equipment. W.B. SAUNDERS CO.

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SOLVING CASES/MANAGER

Case simulations covering a wide range of clinical problems. The manager consists of a set of programs for monitoring student use and performance on the diagnostic problems. Available for Apple II and IBM-PC compatible equipment. HEALTH SCIENCES CONSORTIUM

STEDMAN'S MEDICAL DICTIONARY

Tool containing a main dictionary and two supplemental dictionaries. Apple II compatible equipment. SENSIBLE SOFTWARE, INC.

THE SURGEON

Simulation of surgical correction of an aortic aneurysm. Available for Macintosh equipment. INFORMATION SYSTEMS FOR MEDICINE, INC.

CYTOLOGY

CELL CHEMISTRY I

Tutorial covering various chemical structures. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

CELL CHEMISTRY II

Tutorial covering the chemical and physical processes that occur within cells. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

CELLGROW

Simulation of cell kinetics. Program available for Apple II equipment. UNIVERSITY OF TEXAS SYSTEM CANCER CTR

CELL GROWTH AND MITOSIS

Interactive simulation covering surface area-volume ratio, chromosome number, chromosome replication, and cytoplasmic division. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

CELLS: STRUCTURE AND FUNCTION

Simulation reinforces basic concepts of cell structure, cell functions, water movement and concentration gradients, and diffusion and active transport. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGY

AIR POLLUTION

Simulation of carbon monoxide pollution in an urban environment. Program available for Apple II and TRS-80 Model I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

AQUATIC ECOLOGY

Utilities to perform many of the calculations common to aquatic ecology. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

AQUATIC ECOLOGY DATA SIMULATION

25 simulations covering aquatic systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

ECOLOGICAL DATA SIMULATION

25 simulations covering ecological systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

ECOLOGY

Rote drill reviews and reinforces concepts of general terrestrial, and aquatic ecology. Available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

ECOLOGY

Simulation dealing with plant population sizes and growth pattern. Available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGICAL ANALYSIS - PC

Utilities that perform life table analysis, interspecific association indices, community similarity, diversity indices, descriptive statistics, mark-release recapture analysis, plus regression and correlation analysis. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

ECOLOGICAL ANALYSIS VOL. 2 - PC

Utilities that perform community similarity analysis, indices of dispersion, species-area curve, and step-wise multiple regression. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

ECOLOGICAL ANALYSIS PROGRAMS PLUS

Utilities that perform life table analysis, community similarity indices, diversity indices, predator-prey modeling, mark-recapture analysis, descriptive statistics, plus regression and correlation analysis. Program available for Apple II equipment. OAKLEAF SYSTEMS

ECOLOGICAL MODELING

Series of 7 programs dealing with a variety of techniques for modeling ecological systems and processes. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

NICHE-ECOLOGICAL GAME/ SIMULATION

Game in which students attempt to place an organism in its proper ecological niche correctly by specifying environment, range, and competitor. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

POLLUTE

Simulation of factors affecting water quality. Includes temperature, amount and type of pollutant, and water treatment. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

POLLUTE:IMPACT/WATER POLLUTANTS

Simulation of the impact of various pollutants on typical bodies of water. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

WATER POLLUTION

Simulation of the effects of temperature, type of waste, dumping rate, and method of treatment on the impact of pollution on aquatic life. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

EVOLUTION

EVOLUT: Evolution and Natural Selection

Simulation of fluctuations in gene frequencies of wild populations. Program available for Apple II equipment. CONDUIT

EVOLUTION

Simulations covering mutation, gene flow, natural selection, and genetic drift on populations. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

EVOLVE

Simulation of evolution using the Hardy-Weinberg formula and the population model that has evolved from its application. Available for Apple II equipment. CONDUIT

SIMULATED EVOLUTION

Simulation using animation to provide a graphic illustration of the origin of biological species by natural selection. Available for IBM-PC compatible equipment. LIFE SCIENCE ASSOCIATES

FORESTRY

FOREST FIRE DISPATCHER

Simulation dealing with a ranger district during the forest fire season. Available for TRS-80 III equipment. DUANE BRISTOW

FOREST SAMPLE DATABASE

Two program set that allows development of a database from either variable radius plots or fixed radius plots. Available for TRS-80 I and TRS-80 III equipment. DUANE BRISTOW

GENETICS

ADVANCED GENETICS

Tutorial/Simulation presented as a nine-part program covering dominance and recessiveness, partial dominance, lethality, mechanism of inheritance, multiple alleles, sex linkage, multi-trait inheritance, crossing over, and gene mapping. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

BIRDBREED

Simulation providing 16 breeding groups of birds with defined phenotypes for exploring genetic principles. Available for Apple II compatible equipment. EDUTECH, INC.

CATGEN

Simulation allowing students to mate domestic cats of known genotypes. Program available for Apple II and IBM-PC compatible equipment.
CONDUIT

CATLAB (Second Edition)

Simulation in introductory genetics. Program available for Apple II and IBM-PC compatible equipment.
CONDUIT

CELLS AND GENETICS PICTURE FILE

Hi-Res diagrams of animal cell, plant cell, mitosis, meiosis, Punnett Square, sex linked traits, DNA replication, protozoa, energy reactions, and pedigree. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

DICROSS-DIHYBRID CROSSES

Simulation of various types of dihybrid crosses. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment.
DIVERSIFIED EDUCATION ENTERPRISES

DNAGEN-DNA/GENETIC CODE SIMULATION

Simulation of genetic code to produce protein sequences. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

DNA - THE MASTER MOLECULE

Simulation dealing with DNA structure. Programs available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

FLYGEN

Simulation of monohybrid or dihybrid crosses with 25 varieties of Drosophila. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment.
DIVERSIFIED EDUCATION ENTERPRISES

GENESIM

Simulations of experminents in bacterial and molecular genetics. Program available for Apple II and IBM-PC compatible equipment.
BIOSOFT (UK)

GENETIC ENGINEERING

Contains two gene base sequences plus an option to enter a custom gene, comparing changes to the normal gene. Available for Apple //e (enhanced) and IBM-PC compatible equipment.
EDUCATIONAL MATERIALS & EQUIPMENT CO.

GENETIC ENGINEER'S TOOLBOX

Tutorial introducing the principles and techniques of genetic engineering. Available for Apple II compatible equipment. HRM SOFTWARE

GENETICS

Tutorial/simulation in which the imaginary planet Gensim is a "microworld" in which genetic variation in a native species is determined by patterns of inheritance similar to those of humans. Available for Apple II compatible equipment. AGENCY FOR INSTRUCTIONAL TECHNOLOGY

GENETICS

Tutorial covering various crosses in plants and fruit fly populations. Program available for Apple II and TRS-80 Model III and IV equipment.
J & S SOFTWARE

GENETICS

Tutorial that allows students to explore Mendel's experiments, Punnett Squares, sex linkage in fruit flies, and multiple alleles. Program available for Apple II equipment.
SCOTT, FORESMAN & CO.

GENETICS

Tutorial examines DNA molecule and progresses to applied genetics. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

GENTIC DRIFT

Tutorial-simulation focusing on random changes with time in the distribution of individuals in small populations. Program for Apple II equipment.
QUEUE, INC.

HEREDITY DOG

Tutorial covering various genetic topics. Program available for Apple II and Commodore 64/128 equipment.
HRM SOFTWARE

HUMAN GENETIC DISORDERS

Simulation investigating inherited disorders. Program available for Apple II equipment. HRM SOFTWARE

INTRODUCTORY GENETICS

Three part tutorial covering a variety of topics. Program available for Apple II, TRS-80 Models I and III equipment.
EDUCATIONAL MATERIALS & EQUIPMENT CO.

LIFE

Educational game dealing with changing distributions of individuals. Program for Apple II equipment.
QUEUE, INC.

LINKOVER: Genetic Mapping

Simulation of genetic mapping experiments. Program available for Apple II equipment. CONDUIT

MEIOSIS

Tutorial/Simulation providing an interactive portrayal of gamete formation. Program available for Apple II and IBM-PC equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

MEIOSIS, MITOSIS, PROTEIN SYNTHESIS

Simulation demonstrating mitosis, meiosis, DNA replication, and protein synthesis. Program available for Apple II equipment.
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VENDORS

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Bloomington, IN 47402-0120
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(800) 457-4509

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Iowa City, IA 52242
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Cross Educational Software
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Ruston, LA 71270
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outside USA (800) 967-0192

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Glenview, IL 60025
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Troy, MI 48083
(313) 528-1950

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Suite 11C
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(805) 499-1407

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Philadelphia, PA 19105
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(215) 574-3066

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New York, NY 10158
(212) 850-6009

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Baltimore, MD 21202
(800) 638-0672

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 17

WHERE'S THE SOFTWARE – PART 2 18

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WHERE'S THE SOFTWARE? – PART 2

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on page 22.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

GENETICS (CONTINUED)

MENDELIAN GENETICS

Simulation covering dominance, partial dominance, lethality, linkage, and sex linkage. Program for Apple II equipment. QUEUE, INC.

MONOCROS-MONOHYBRID CROSSES

Simulation of various monohybrid genetic crosses. Program available for Apple II, TRS-80 models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

NATURAL SELECTION

Tutorial/Simulation dealing with genetics and evolution to populations. Available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPGEN-POPULATION GENETICS

Simulation of the effects of Hardy-Weinberg Law conditions on gene, genotype, and phenotype frequencies of a population over time. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

MICROBIOLOGY

DILUTE-MICROBIAL DILUTION SERIES

Simulation covering design and testing of microbial dilution series to determine concentration of a bacterial solution. Program available for Apple II, TRS-80 Model III, IBM-PC, Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

MICROBIOLOGY TECHNIQUES

Tutorial/Simulation covering various laboratory procedures. Available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

NEUROSCIENCE

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

HUMAN BRAIN: NEURONS

Tutorial covering neuronal structure, types of neurons, electrical potentials, synaptic transmission, and neurotransmitters. Available for Apple II compatible equipment. BIOSOURCE SOFTWARE

LOLIGO ELECTRONICUS

Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. BIOSOFT (SD)

MODEL NEURON

Simulation of the behavior of an isolated neuron. Program available for Macintosh equipment. KINKO'S

NERVE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NEUROMUSCULAR CONCEPTS

Tutorial covering muscle action potentials, use of electromyograph, contraction, muscle action and movement disorders. Program for Apple II equipment. BIOSOURCE SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. BIOSOFT (UK)

NEURO-SYS

Tutorial that teaches the basics of neuroanatomical techniques that are commonly used to trace nerve fibers and their interconnections. Available for IBM-PC compatible equipment. BIOSOFT (UK)

NURSING

For an extensive list of educational software for nursing, consult the Directory of Educational Software for Nursing published annually by the National League of Nursing, 10 Columbus Circle, New York, NY 10019. (800) 847-8480 and Annual software exchange published in Computers in Nursing (March/April, 1989 Supplement)

PHARMACOLOGY

CARDIAC PHARMACOLOGY

Simulation of cardiac activity in response to a variety of pharmacological agents. Available for IBM-PC compatible equipment. WALKER, DR J.R.

CARDIOLAB

Simulation of cardiovascular pharmacology experiments. Available for BBC, Apple II, and IBM-PC compatible equipment. BIOSOFT (UK)

EFFECTS OF DRUGS ON THE UTERUS AND THE INTESTINE

Simulation of uterine activity and intestinal smooth muscle. Available for IBM-PC compatible equipment. WALKER, DR. J.R..

ILEUM

Simulates laboratory experiments investigating effects of drugs on the *in vitro* guinea pig ileum. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

COMPUTER ASSISTED INSTRUCTION IN AN HISTOLOGY COURSE 25
Ronald P. Jensh

WHERE'S THE SOFTWARE – PART 3 29

NRCLSE SOFTWARE EVALUATION SUBMISSION FORM 30

COMPUTER ASSISTED INSTRUCTION IN AN HISTOLOGY COURSE

Ronald P. Jensh

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Computer assisted instruction (CAI) is a valuable addition to methodologies currently available for medical educators. The effectiveness of CAI, however, depends to a great extent on creative planning, effective programming, appropriate content, and an understanding of the nature and background of the users. At the outset, one must be able to clearly identify the needs of the user, the environment in which CAI is to be used, and the goal of CAI programs within the educational environment. Often there has been too much emphasis on the computer as the endpoint instead of as a means to facilitate educational needs.[2]

In 1983, it became evident to us that CAI could be a useful teaching tool in histology. Although there were numerous programs available or being developed at the public school and undergraduate college and univeristy levels, and some programs were being designed for students in the upper two years (clinical) of medical school, there was a paucity of basic science CAI programs for student use during the first two years of medical school. Programs that were available

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were of variable quality and often did not address the needs of schools due to differences in curricula.

During the summer of 1984, the first CAI program was complete at Jefferson Medical College for one topic in medical histology using a commercially available authoring system. Three programs in histology were created in 1985. It became evident, however, that these programs were limited, as computer generated graphics did not adequately address the needs of a morphologic science such as histology. With the advent of videodisc technology and the ability to interface videodisc players easily and inexpensively to computers, CAI became an appropriate educational tool for the morphologic sciences.

Three years ago, an experimental videodisc was produced containing over 1000 photographs that could be used to create computer assisted instruction, interactive video programs (CAI-IV). At that time, the following three common errors were identified and addressed.

- Although commercially available authoring systems were very sophisticated and impressive, they were too complex for faculty who might want to produce programs but did not have the time to learn such complicated systems.
- The cost of many computer system was too high, resulting in limited hardware availability to schools.
- Technology changes so fast that systems and software became "obsolete" in months.

Many people changed systems in order to keep up, the net result often being that projects never could be taken to completion. Therefore, in 1986, decisions were made to a) design an inexpensive workstation and stay with that technology, and, b) instead of concentrating on producing individual programs, create a simple, easy to use authoring system that, although more restrictive, would permit faculty with minimal computer knowledge to produce a tutorial or quiz within a few hours. By the end of the summer of 1987, the authoring system was completed, and two tutorials were created and evaluated.[5] The objective of the present study was to produce a complete set of programs for use by first year medical students in the medical histology course for the fall of 1988 and to solicit student evaluations.

Table 1. Order of topic presentation in the first year histology course.

Epithelium
Connective tissue
Adipose tissue
Cartilage
Bone
Muscle
Nerve
Quiz #1
Peripheral blood
Hemopoiesis
Circulatory system (vascular)
Lymphatics
Integument
Glands
Digestive system
Quiz #2
Respiratory system
Endocrine system
Male reproductive system
Quiz #3
Urinary system
Female reproductive system
Special senses (eye, ear)
Final quiz

METHODS AND MATERIALS

A workstation was created which consisted of an Apple //e computer with an accelerator card, two 5.25" disk drives, a Zenith Data System 12" monochrome monitor (Model ZVM-121), a Sony Trinitron 13" color monitor (Model KV-1311CR), a Pioneer LD-V1000 Video Disc Player, and a Video Microcomputer Interface card (Allen Communications, Inc.). The first three items were readily available in the medical college, so the additional cost to complete the workstation was under $1200. The hardware was placed on a mobile card that allowed transport of the workstation to student laboratories, faculty offices, and study areas, as needed. The workstation and software were made available to the 236 first year students at Jefferson Medical College during the fall, 1988, when the medical histology course was offered.

During the summer of 1988, twenty tutorials and four quizzes were created covering the entire first year medical histology course. The tutorials consisted of written text for each subject in histology with some applicable gross anatomy, biochemistry, physiology, and some clinical information included. Text material was presented on the monochrome monitor paired with a photograph from the videodisc displayed on the color monitor. Sources included textbooks, atlases, lecture notes, and published articles. The order of presentation of the twenty-four programs in the histology course is shown in Table 1. Because up to 40% of the students had little or no computer expertise, the workstation and programs were designed so students only needed to be shown how to insert the videodisk and floppy disk into the drives and turn on the unit.

During the final week of the course, the entire class was asked to complete an evaluation of the CAI-IV program. The questions asked on the evaluation are presented in Table 2.

An objective evaluation of changes in student grades due to exposure to CAI-IV was not done because only one workstation was available for the class, severely limiting the time for students to access the computers. In addition, the medical student population is very homogeneous academically, and, therefore, a major change in test results would not be expected, given the logistical constraint previously mentioned. It was felt that student perception of the effect of CAI-

IV on their learning ability and efficiency was a valid parameter to measure at this time.

RESULTS

Student reaction was uniformly positive, and the workstation was in constant use throughout the teaching block. In many instances, the workstation had to be moved into a hallway to accommodate eight to ten student at a time. When groups used the workstations, the programs became the focus for informative discussions among students.

Ninety students representing 39% of the class, responded to the questionnaire. Forty-five percent used more than nine programs, and 48% used between one and eight programs. Sixty-seven percent found the programs to be helpful, while three percent did not. Twenty-seven percent of the students estimated an increase of five or more points to their grade as a result of exposure to the CAI-IV programs; 31% felt there would be little or no effect on grades. Over 96% of the students responding found the programs informative, personable, and enjoyable. Seventy-four percent felt that the programs inhanced their educational experience, and over 98% believed that more workstations should be built and more programs should be created; 90% affirming that such an activity should take place as a college-wide commitment. Although students felt that CAI-IV should not replace human interaction, almost 75% felt such programs could replace certain lectures that were perceived to be of low quality by the students. All criteria listed, concerning educational activities, were considered extremely to very important with two exceptions. Of moderate importance to students was the form of the content and individualization of programs. Of the responses to questions 21-22, the majority indicated that the students participated in the CAI-IV educational experience to obtain additional help with the subject matter and that their expectations were fulfilled. The only major criticism was the lack of additional workstations.

DISCUSSION

Computer assisted instructional materials are a new and potentially valuable addition to the medical education armamentarium. Today's medical students have been raised in a era in which computer technology has become an ever increasing part of everyday personal and professional life.[1,3,4] Therefore, they feel comfortable with computer programs and are beginning to expect that such programs should be available to them as part of what they consider to be quality education. The workstation with associated software is a step toward providing students with the most up-to-date educational techniques.

There are a number of advantages related to the use of CAI-IV. First, one has control over the content and emphasis of

Table 2. Evaluation survey presented to students following use of CAI-IV.

1. Did you use any of the 24 programs?

2. Do you believe that these programs aided in your understanding of the material?

3. What grade do you expect to receive?

4. By how many points do you estimate your grade increased by use of these CAI-IV programs?

5. Were the programs informative?

6. Were the programs enjoyable and personable?

7. Do you believe more workstations should be built?

8. Do you believe more CAI-IV programs should be developed?

9. Do you believe computer programs in general enhanced you educational experience?

10. Do you believe Jefferson should commit more resources to the development of such technology at the departmental/college level?

11. Should CAI-IV techniques replace lectures?

12 - 20. Evaluate the importance of the following criteria in evaluating educational activities:
    Informational content
    Form in which content is presented (brief/non-redundant)
    Learner active
    Individualized
    Utilization of graphic images
    Connections across different topics emphasized
    Activities enjoyable and personable
    Non-judgmental approach

21. Why did you participate in this activity (reasons/objectives)?

22. To what extent were your expectations fulfilled?

23. What effects, if any, did participation in CAI-IV have on your other study behavior?

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the material being presented. For example, the respiratory system chapters presented in four of the histology textbooks most commonly used by medical schools were compared. Text length varied from about 5,000 to over 13,000 words. Second, the number and quality of illustrations can be planned. Third, the orientation, emphasis, and quality of photographs can be precisely controlled. Light microscopic photographs as a percent of total illustrations in the four texts varies from 21% to 62%, electron photomicrographs from 10% to 58%, and diagrams and drawings from 28% to 66%. Another advantage concerns the elimination of lead time associated with text production, which may be several years behind current concepts. It is important to emphasize, however, that written material cannot be totally eliminated. CAI is a valuable educational addition to existing educational modalities with strengths and limitations, advantages and disadvantages, that must be recognized if it is to be used properly and effectively. Each student has his or her own individual way of using the various educational tools available to maximize his or her learning experience. CAI-IV is a method that students readily accept and that they perceive as being very helpful in assisting them to understand complex material. Ninety-seven percent of the students who used these programs felt that more resources should be committed to develop additional materials.

The process of creating the 24 programs was accelerated by using a very simple, straightforward authoring system. Although the system had to be limited in its options in order to maintain simplicity, the programs were very effective from the user's standpoint. The ojection has often been raised that tutorials are simply pageturners. However, the validity of such programs rests with the nature of the material, the objectives that are to be achieved, and the environment in which the programs will be used. The success of the CAI-IV tutorials amply justifies the format that was used in the design of the authoring system. A second criticism has been that programs that run on older computers are too slow. The present programs have a cycle time (the time taken to present successive pairs of text and photograph on the two monitors) of about five seconds. This was not a problem for the students, and they were generally unaware of the time interval, since they were involved in discussions among themselves.

Computer technology will continue to make an ever increasing impact on the field of medicine and will greatly influence the way students are taught, patients are cared for, and research is conducted. It is important, therefore, that medical educators use this technology and sensitize students and faculty to the advantages that computers offer to the medical community.[6] During the histology teaching block, students were constantly using and reviewing the CAI-IV programs to the extent that it was difficult to find time when the computer could be used for other activities. Clearly, our experience has indicated that students enjoy this type of educational exposure, and the majority feel the use of CAI-IV assisted in their better understanding of the material. This study has indicated, therefore, that CAI-IV is a valuable addition to educational technology. Additional workstations are being assembled, and the content material is being redesigned and updated. The two programs have recently been redesigned using a Macintosh computer and Hypercard®. These programs are currently being evaluated as part of our commitment to meet the continuing needs of today's medical students.

The author wishes to acknowledge the contributions made by the following individuals: David Battaglia, M.D.; Francis Gentile, M.D.; Robert C. Weber, III, M.D.; Timothy J. O'Brien; Michelle Vichnin; J. Jon Veloski; and F. Scott Beadenkopf. Special thanks is also given to the Office of the Dean and to the Center for Research in Medical Education and Health Care. This research was supported through the Summer Fellowship Program for Research in Medical Education and the Mr. and Mrs. Gabriel Lavine Clinical Scholarship Program of Jefferson Medical College of Thomas Jefferson University.

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-NOTICE-

NRCLSE announces a new version of *Simulations in Physiology –The Respiratory System* – for Macintosh computers. Unlike the older version that required Microsoft BASIC, the programs in the new version run as independent applications and, therefore, require no special support software.

WHERE'S THE SOFTWARE? – PART 3

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor name relating the software to the vendor list that follows the software list.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

SUBSTANCE ABUSE

DRINKING AND NOT DRINKING

Tutorial designed to augment strategies for the prevention of substance abuse. Includes facts about drinking and the effects of alcohol. Program available for Apple II equipment. KINKO'S

INTRODUCTION TO PSYCHOACTIVE DRUGS

Tutorial designed to augment strategies for the prevention of psychoactive drug abuse. Program available for Apple II equipment. KINKO'S

KEEP OFF THE GRASS

Tutorial designed to augment strategies for the prevention of marijuana abuse. Program available for Apple II equipment. KINKO'S

SIX CLASSES OF PSYCHOACTIVE DRUGS

Tutorial designed to augment strategies for the prevention of psychoactive drug abuse. Program available for Apple II equipment. KINKO'S

SUBSTANCE ABUSE DATA BASE

Database containing contact information on substance abuse organizations. Program available for Apple II equipment. KINKO'S

ZOOLOGY

ZOOLOGY I

Tutorial covering the general charactistics, structures, and functions that define the major invertebrate phyla. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

ZOOLOGY II

Tutorial covering physiology in the Phylum Chordata. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

MISCELLANEOUS

BAFFLES, BAFFLES II

Game to help students develop deductive reasoning and problem solving skills. Program available for Apple II (BAFFLES) and IBM-PC compatible (BAFFLES II) equipment. CONDUIT

BASIC SCIENCES

Self-assessment package covering anatomy, behavioral science, biochemistry, microbiology, pathology, pharmacology, and physiology. Available for CP/M and IBM- PC compatible equipment. UMKC SOFTWARE SERIES

CLASSIFY-CLASSIFICATION KEY PROGRAM

Presents an unclassified set of characteristics and labels for classification at various levels. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GRADE KEEPER - PC

Grade book manager that handles classes up to 300 students, up to 25 grades per student. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

GRADEBK

Program for the analysis of a large set of grades. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

LABPLOT

Allows the Apple II with any A/D converter card to be used as a multipen chart recorder or as an X/Y plotter. BIOSOFT (UK)

LIFE TABLES AND THE LESLIE MATRIX

Tutorial-simulation dealing with the basic life table and Leslie Matrix. Program available for Apple II equipment. CONDUIT

MALARIA

Simulation of the effects of various types of malaria epidemic controls. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

MULTI-Q

A general purpose question creation and presentation system. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

"Q" EDUCATIONAL AUTHORING SYSTEM

Authoring system for tutorial and assessment material. Allows incorporation of graphics and videodisc material. Program available for IBM-PC compatible equipment. BIOSOFT (UK)

RATS

Simulation of rat control in city or apartment by sanitation and various poisons. Program for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

STERL

Simulation exploring effectiveness of pest control methods. Program available for Apple II, PET/CBM, and TRS-

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80 Model III equipment. COMPUWARE

TRACER AUTHORING SYSTEM
Designed for faculty use to develop diagnostic case simulations in any branch of medicine. Available for IBM-PC compatible equipment. HEALTH SCIENCES CONSORTIUM

TRIBBLES, TRIBBLES Revisited
Simulation to introduce students to the scientific method. Programs available for Apple II (Tribbles) and IBM-PC compatible (Tribbles revisited) equipment. CONDUIT

VENDORS

BIOSOFT (UK)
22 Hills Road
Cambridge CB2 1JP, United Kingdom

P.O. Box 580
Milltown, NJ 08850

Compuware
15 Center Road
Randolph, NJ 07869
(201) 366-8540

CONDUIT
The University of Iowa
Oakdale Campus
Iowa City, IA 52242
(319) 335-4100

Diversified Education Enterprises
725 Main Street
Lafayette, IN 47901
(317) 742-2690

Indiana University School of Medicine
Department of Physiology and Biophysics
635 Barnhill Drive
Indianapolis, IN 46223

Health Sciences Consortium
201 Silver Cedar Court
Chapel Hill, NC 27514
(919) 942-8731

Kinko's Service Corporation
4141 State Street
Santa Barabara, CA 93110
(800) 235-6919
in CA (800) 292-6640

Oakleaf Systems
P.O. Box 472
Decorah, IA 52101
(319) 382-4320

Sliwa Enterprises, Inc.
2360-J George Washington Hwy
Yorktown, VA 23666
(804) 898-8386

UMKC Software Series
2411 Holmes Street
Kansas City, MO 64108-2792
(816) 276-1891

NRCLSE SOFTWARE EVALUATION SUBMISSION FORM

The NRCLSE software evaluation program has been initiated (see October, 1988 CLSE) to promote development of high quality, versatile educational software in the life sciences by providing authors with feedback from critiques by life science educators and instructional designers. To ensure that software is reviewed in an appropriate fashion, it is essential that reviewers fully understand the rationale underlying the design criteria chosen by the author and the environment for which the software is intended. Please provide the following information concerning each software package to be evaluated.

Submit 3 complete copies of the software and all supporting documentation along with $25 (to cover handling, mailing, and follow-up costs) **to Software Evaluation Program, NRCLSE, P.O. Box 51187, Seattle, WA 98115.**

Author's name:

Author's address:

Title of software: **Content area:**

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Minimum hardware requirements:

Optimal hardware configuration:

Software requirements (operating system, etc):

Student population for which software was written:

Environment for which software is primarily intended (independent study, classroom discussion, lecture enhancement, etc):

How long has this software been used by students?

Can reviewers keep the review copy of this software?

Use additional pages to describe the underlying philosophy of this software. What need prompted the development of this software? Why was the specific format of the software chosen? What goals did the input/output scheme (or screen design) address? Is documentation an integral part of the package? How is it intended to be used?

Has the software been evaluated by students?

Briefly describe the format and results of any student evaluation.

What attempts have been made to evaluate the impact of the software on student progress?

What were the results of the impact evaluation?

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

BIOLOGY COURSEWARE FOR COLLEGE FRESHMEN 33
Charles L. Ralph

WHERE ARE THE VIDEODISCS? 37

BIOLOGY COURSEWARE FOR COLLEGE FRESHMEN

Charles L. Ralph

Department of Biology, Colorado State University, Ft. Collins, Colorado

This article is an account of my use of computer software (courseware) in freshman biology courses and recent development of a large, uniform set of biology courseware. In the evolution of a format for employing computerized instruction, I have formed some pragmatic views on courseware as instructional tools. There are interesting discrepancies between what is perceived as needed and what actually works. Additionally, there is considerable whimsy in the dispensing of accolades for and funding of courseware development.

If one asks college faculty what kind of courseware they would like to see developed, chances are their response will be "simulations." If you ask college students what they find most interesting and useful, after they have experienced a few samples of courseware, they will most likely say "tutorials." Alperson and O'Neil have addressed this issue.[1]

My experience in seeking funding for courseware development suggests that those agencies dispensing such monies, both private and government, are having difficulty defining what they want to see produced. There are shifting emphases and ephemeral interests, due undoubtedly to not knowing what college level courseware really should be, for there are no well tested examples extant. My perception is that funded projects are commonly ones that will result in a piece or a few pieces of comparatively spectacular looking software with little potential for widespread, practical use.

The award and recognition organizations, such as the commendable one of the EDUCOM consortium, likewise appear to commonly select items with much panache but small likelihood of being broadly disseminated.[2,4] That is, a few pieces of courseware, scattered among various disciplines, are not likely

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to fuel a revolution in instruction, no matter how good they are, for unless there is a critical mass of programs that can be assembled to make a functional package, potential users are unlikely to bother tooling up to use them.[6]

What we are now witnessing is the trial-and-error phase of a still relatively new revolution in educational technology. Our acceptance and use of this technology within colleges and universities has been rather fumbling and is appropriately viewed internally with conservatism or even suspicion by many. While the business community has clearly articulated how computers can serve them, educators do not find it easy to voice any collective or majority opinion on what the role of computers might be in their domain.

RATIONALE

In 1984, I became intrigued with the possibility of using courseware as a component of the laboratory with the freshman biology classes I was teaching. My basic assumptions or premises were the following.

1) Much of the understanding of biology depends on grasping the complexities of physical structure or imagining submicroscopic, abstract events. The pictorial and animation capabilities of the computer screen should aid such comprehension. [3]
2) Biological information grows ever more voluminous, and the time allocated for its study has not increased. Indeed, the allocated time has decreased in most schools. The potential efficiencies of computer simulations of long-term events are evident. In some cases, the computer can provide an active learning experience that addresses the same goals as the traditional student laboratory.[5]
3) The cost of materials, equipment, and personnel are increasing, while the relative cost of computers (on a capability basis) is decreasing, so that use of courseware is now, or soon will be, cost effective in instruction.
4) Increasing awareness of ethical concerns about the uses of animals in student laboratories encourage conservation as well as concern about the preparedness of students to employ animals. Appropriate courseware can reduce some uses of animals and better prepare the students for the occasions when they do use animals.

HISTORY OF BICEP

In January, 1985, I modified the laboratory with my freshman biology class to incorporate a few proprietary courseware programs. These were mounted on Apple //e computers. The available appropriate courseware was limited, but I selected what appeared to be the best from some half dozen sources. The format that developed over the next 3 years was to have the 2-hour per week laboratory be a mix of traditional, hands-on exercises and courseware study. There were two students for each of 10 Apple computers (the //es were replaced by IIGSs with RGB monitors in the third year). On average, over the course of the semester, the students spent about half of their time on each two components. Repeated, anonymous questioning of the students revealed a very favorable acceptance of this mix. The design was tried with both the first and second semester biology courses, with a non-majors course and with summer courses for high school teachers. In all cases, student acceptance of the format was very positive.

By the third year, this design was well implemented, our courseware library consisted of 10 copies each of 43 titles. The project came to be known as BICEP for Biological Instruction Computer Enhanced Project.[7]

The major problems with using an assortment of courseware from various providers are non-uniformity of the interfaces, necessitating the use of documentation to know how to control each program's unique features, and the intermixing of color and monochrome programs; many of the monochrome programs that are not updated are very difficult to read on color monitors (especially composite video monitors); switching between color and monochrome monitors is feasible if one has a dual set but is inconvenient. Additionally, there is great variance in scholastic level. Many programs are designed to appeal to as wide an audience as possible (secondary to college), which sometimes results in some unusual mixes of cuteness and rather sophisticated information. Also the run times vary widely among programs. Nevertheless, this phase of my explorations into computer-enhanced instruction was a necessary, useful, and encouraging beginning. It gave me valuable insight and practical understanding about students as they relate to and interact with computers and courseware. In 1988, through a grant from the Colorado Commission on Higher Education, we secured a set of 14 Macintosh Plus computers and began developing plans for creating, in-house, a set of courseware to exploit them. Subsequent donations from Apple Computer, Inc. have added to our set of student computers, bringing the laboratory set to 20.

I became interested in the Macintosh as an instructional computer the first time I saw one. Its crisp screen and graphics capability provided, for the first time, a pictorial environment suitable for displaying the visual metaphors that aid in understanding biology. I then began casting about for a framework in which to create courseware for the Macintosh. While despairing of ever producing a significant set of products in my lifetime through coding, my attention was called to an early version of the on-screen, iconographic authoring program that has come to be called Authorware. I recognized that this was the very tool I was seeking, for a non-programmer can create with it dynamic courseware at a pace previously impossible.

BICEP COURSEWARE

By the summer of 1988, I had resolved to produce, using the Authorware framework, a set of complementary courseware for use in the freshman biology year. To date, there are 40 titles in the set, created over the past two years. These programs cover topics typically taught in basic biology courses (see Table 1).

Table 1. Titles of biology courseware developed to date.

Biochemistry
Cells
Membrane Permeability
Enzyme Kinetics
Oxidation-Reduction
ATP Synthesis
Photosynthesis I
Photosynthesis II
Mitosis
Meiosis
Genetic Experiments
Molecular Genetics
Protein synthesis
Viral and Bacterial Genetics
Eukaryotic Gene Expression
Genetic Engineering
Microevolution
Macroevolution
Animal Reproduction
Animal Development
Adaptations
Biomes
Population Growth
Communities
Ecosystems
Behavior
Classification of Animals
Invertebrates
Chordates
Animal Structure
Digestive Enzymes
Countercurrent Exchange
Respiration
Immune System
Osmoregulation
Kidney Function
Hormonal Regulation
Blood Glucose
Neural Transmission
Muscles

What remains to be created are programs in plant biology. These are to be done in the coming summer. Twelve titles will be added, bringing the total set to 52. This number allows running two titles per week in each of the 13 laboratory sessions held in each of two semesters.

The success of the project in creating so many programs in a remarkably brief time is largely due to the efficiencies of creation with the iconographic authoring program and the splendid creativity of the undergraduate students who authored most of the programs. I created one-fourth of the programs and edited the remainder, but many of the best features of our programs must be credited to the seven talented undergraduates who have worked in the project. This statement may draw skepticism from some readers. (The use of undergraduate authors has been viewed with doubt by funding agencies, as I will note later.) Nevertheless, I remain convinced that selected, well-trained undergraduates can be the very best hope for the production of excellent, functional courseware in quantities sufficient to be significant. Neither faculty nor graduate students are likely to be the source of any great quantity of software very soon, due to the nature of our academic award structure and traditions.

From the hundreds of students in introductory biology, I encourage a few that are interested to enroll in my one credit applications course. This course formerly used Appleworks with the Apple //cs® but now uses Microsoft Works on the Macintoshs. The students produce a paper on a biological topic as the final product, having learned some interesting information on a subject and how to present it in good form. At the next level, a one credit drawing, painting, and modeling course, they learn the graphic capabilities of the Macintosh. Then a two credit authoring course instructs in the use of Authorware. From the latter class (usually six to eight students), I select three or four to be paid interns for the summer authoring project. Through this sequence I identify the best candidates for the task. The prime factor to be selected for is creativity. Subject knowledge is essential, but secondary to creativity.

The BICEP programs have a run time of about 40 minutes. Typically there are four topics plus a multiple choice quiz. The programs are mainly tutorial, with generous used of graphics, animations, and a few sounds. The fourth topic commonly is a simulation. All programs have the same style and appearance. Each has a pull-down glossary that defines the arcane words in the program. There is much student interaction, including click-and-drag arrangements, typing of responses to questions, and selection of program sequences.

UTILIZATION AND TESTING

In the 1988-89 academic year, the 20 programs then available were used by the students as optional sources of information. A Macintosh facility was available for several hours daily for student to run the courseware. We asked them to report errors and complete an evaluation form on each program to help shape and improve the programs.

In the fall of 1989, a formal test with 26 of the programs was conducted. My lecture section of almost 200 students was subdivided by laboratory sections into half that did traditional two hour laboratory exercises and half that ran two courseware programs in their assigned two hour periods. This design was approved by the university's Human Research Committee, with the proviso that a student's final grade would not be disadvantaged by either set of conditions. The results of this matched-sample study, with pre- and post-test comparisons, as well as computer attitude surveys, are in analysis and will be published at a later date. In brief, both groups of students did equally well on the lecture examinations, and the courseware was viewed very favorably as a trade-off for traditional laboratories.

In the present semester, with the second biology course, a format is being tried that I find very satisfactory so far. There are the customary three lectures per week, but the required two hour, weekly laboratory period is devoted to the running of two relevant courseware programs. A written quiz is administered by the supervising teaching assistant at the end of the session. Additionally, there is a one hour, weekly, optional practicum (no attendance check, no exams), in which most of the traditional laboratory activities are done. Only about half the students attend practicums. Presumably, these self-selected students are the better or more motivated ones.

END NOTES

Funding from within my university for BICEP has been generous and unwavering, for which I am most grateful. Because I am a senior faculty member, I was safely able to make a major investment in this project. As it became a consuming activity, I deliberately phased out of an established research career, to the dismay of some of my colleagues. I have found the transition to a more teaching oriented career revitalizing and recommend it to others. However, anyone making a major commitment to implementing computer enhanced instruction should be in a position where such efforts do not require recognition for academic success. Most university communities, especially ones with a research emphasis, are not likely to regard courseware creation as a scholarly activity.[6]

There is considerable resistance to diminishing the traditional student laboratory experience. I understand the concerns of my colleagues in protecting this time honored activity, and I will never claim that computer programs can adequately replace real laboratories. However, I view our educational dilemma as one of how to optimally use limited time to educate a generally illiterate and ill prepared population of students in the intricacies of a complex science. My bias is toward exposure to the comparatively information rich environment of courseware, even at the expense of laboratory time. After all, for the successful student, the first year laboratory will not be the last one — unless there is no second or subsequent year in science, which may well be the case if the student fails to learn a great deal in a brief time.

If one were to emulate the BICEP design and attempt to obtain funding from external sources, the applicant should be aware that the the use of undergraduates as courseware authors is likely to be regarded negatively. I have tried for three years to obtain funding from the U.S. Department of Education Fund for the Improvement of Postsecondary Education (FIPSE). I quote from their most recent rejection: "In your proposal, you describe plans for using undergraduate students to create new biology software .... This could certainly be a valuable learning experience for the students involved, and it may generate plenty of useable material. Although students can certainly play valuable roles in tasks such as programming or providing feedback, FIPSE staff is nevertheless concerned that in this project, conceptual innovation and pedagogical sophistication would be limited by their lack of teaching experience and disciplinary knowledge. FIPSE only wishes to support software development ... that will lead to curricular innovation."

To the best of my knowledge, our courseware set is the most comprehensive for basic biology in existence. Teachers who have seen the programs usually commend them for attractive appearance, standardization of operation, quality and quantity of graphics, and the high degree of student interaction. By making available a large package of uniform, practical courseware at a reasonable cost, we hope to persuade others to incorporate computer enhanced instruction in their basic biology courses.

The form in which the courseware will be available and the costs for it should be decided by the end of the coming summer. The programs require minimally a 1 MB Macintosh Plus or a 640K IBM-PC equipped with a mouse. Those wishing to obtain samples of the programs should contact me at the following address: Charles L. Ralph, Department of Biology, Colorado State University, Ft. Collins, CO 80523.

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WHERE ARE THE VIDEODISCS?

Applications of interactive video in life science education continues to grow. As the cost of the technology necessary to implement interactive video falls within the feasibility range of institutions and the interest in Hypermedia continues to grow, more educators are looking for sources of video images or interactive video courseware to use in their teaching efforts. Perhaps the best resource for learning what videodisc material is available on the market is *The Videodisc Compendium for Education and Training* published by Emerging Technologies Consultants, Inc. The videodisc information that follows was drawn from that publication and it updates. Each entry in our listing includes the title, a *brief* overview of the content, the vendor, and the vendor's telephone number. The *Compendium* contains a more detailed description of the material. For information concerning the *Compendium* or for assistance in locating appropriate videodisc material, contact Richard Pollak, Emerging Technology Consultants, Inc., P.O. Box 12444, St. Paul, MN 55112, telephone: (612) 639-3973.

ANATOMY AND PHYSIOLOGY

Anatomy and Physiology of the Heart 24 modules covering various aspects of normal and abnormal cardiac anatomy and physiology. *Compatible with:* IBM InfoWindow *Vendor:* British Columbia Institute of Technology (604) 432-8376

Cardiovascular Lab Simulation Simulation of experiments in cardiovascular physiology. Covers experimental preparation, autonomic control, cardiac catheterization, positive pressure ventilation, fibrillation, manometer experiments, the normal and abnormal cardiac cycle, and euthanasia. *Compatible with:* IBM InfoWindow or Matrox VGO-AT overlay board; Pioneer LD-V4200 or LD-V6000 *Vendor:* Dr. Charles Branch, Auburn University (205) 844-5414

Life Sciences Sides 5-6: The Frog Contains anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Living Textbook - The Frog Interactive MultiMedia Library Contains slides and movie clips covering all basic concepts in the anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

Regulating Body Temperature (2nd Ed.)/ Digestive System (2nd Ed.) Deals with temperature regulation in vertebrates and the mechanical and chemical processes of digestion. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

Work of the Heart (2nd Ed.)/Muscles: Structure and Function Animated footage illustrates the parts of the heart and how they relate to the work of the lungs, arteries and veins. Muscle portion deals with the three types of muscles. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

BIOLOGY - GENERAL

Bio Sci Videodisc A visual presentation on the broad scope of biology. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Life Cycles Visual record in both motion picture and still frame images of how life begins. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Life Science Biology I and II Deals with effects of temperature and pressure on respiration rates of a series of organisms and examines the influence of climatic environments on the characteristics of plants and animals. *Compatible with:* IBM-PC; Pioneer LDV-6000 series *Vendor:* GPN (800) 228-4630 (402) 472-2007

Life Science Sides 1-4: Molecular, Cell, Human, Plant and Animal Biology Provides broad basic coverage of all topics in life science/biology. *Compatible with:* Pioneer LDV-2000 or 4020 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Bio Libe Encyclopedia Contains 6000 color frames of over 5000 plant and animal species accessible by Genus species names. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (612) 644-7802

The Living Textbook - Life Science Interactive MultiMedia Library Contains more than 2,700 slides and 164 movie clips covering all basic concepts in life science/biology taught at the secondary and college levels. *Compatible with:* Apple IIGS or Macintosh; Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

Relationships Covers relationships among organisms including parasites, colonies, social insects, predators, prey and competition. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

BIOTECHNOLOGY

Biotechnology: Learning the Techniques Step-by-step presentations of 33 standard laboratory protocols. *Compatible with:* Any player *Vendor:* GPN (800) 228-4630 (402) 472-2007

BOTANY

Exotic Plants: A Videodisc Compendium Contains over 2,000 high quality color photographs of tropical, subtropical and other exotic plants. *Compatible with:* Any player *Vendor:* VT Productions (408) 438-3100

Landscape Plants Over 7,400 views of over 900 species or varieties of cultivated woody plants. *Compatible with:*

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Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Pollination Biology Documentary dealing with all facets of flower pollination. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

CELL BIOLOGY

Cell Biology I: Motion and Function of the Living Cell Includes film sequences and still images covering cell types, cell constituents, mitosis and cytokinesis, fission and cell motility. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Meiosis (2nd Ed)/Mitosis (2nd Ed) Microscopic footage and animation dealing with the processes of meiosis and mitosis. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

CLINICAL MEDICINE

Abdominal Stab Wounds Simulation designed to teach the initial assessment process. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Active Knee Series A library of programs examining the diagnosis of knee injuries by any person who is first to respond. *Compatible with:* IBM InfoWindow, Sony and other players *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

American Heart Association: Airway Management Basic non-invasive and specialized invasive procedures of airway management. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Arrhythmia Recognition Material from American Heart Association ACLS text, ECG lessons, ECG static and dynamic examples. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

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American Heart Association: Circulatory Adjuncts and Resuscitation Pharmacology Teaches basic techniques of starting IVs, patient defibrillation and cardioversion, and external and transvenous pacin. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Megacode Trains individuals in organizing and managing cardiac emergencies through simulations. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

A Patient with Diarrhea and Vomiting Presents a patient in the emergency department with flu-like complaints of vomiting and diarrhea. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Auscultation of Normal Breath Sounds Reviews standard procedures to auscultate the posterior and anterior chest, patient positions, breathing techniques and stethoscope placement. It also reviews intrathoracic dynamics and the physical dynamics of chest tubes. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Balancing for Diabetic Control Designed to teach students principles of diabetic management. Two case studies are presented. *Compatible with:* IBM-PC compatible and Pioneer LDV-6000 series *Vendor:* Stewart Publishing, Inc. (703) 354-8155

Cardiovascular Resources Videodisc Contains a large collection of materials that may be used to teach cardiovascular nursing and medicine. *Compatible with:* any player *Vendor:* University of Washington (206) 545-1186

Care Basics for Nursing Assistants Introductory course to meet training needs of nursing assistants working in longterm care. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems, Online GL512, VAL *Vendor:* Professional Training Systems, Inc. (404) 872-9700

Chest Trauma Presents a patient with respiratory distress and hypovolemic shock resulting from multiple injuries sustained in a car accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Dysrhythmia Training and Evaluation Designed to train students in electrocardiography with a focus on dysrhythmia recognition. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Emergency Simulation designed for paramedics, emergency medical technicians, emergency physicians, nurses, and others with a background in emergency training. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers Inc. (403) 462-6365

Emergency Cardiac Maneuvers: A Rescuer's Handbook Covers general information, anatomy and physiology, rhythm problems, and rescue maneuvers. *Compatible with:* any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Estrogen Replacement Therapy Covers the reasons for the therapy, details on the therapy, medical evaluation procedures, and the side effects and risks of using this therapy. *Compatible with:* IBM InfoWindow *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Health History/Physical Exam of the Diabetic Clinical simulation followed by an examination. *Compatible with:* IBM-PC, Pioneer LDV-6000 Series *Vendor:* Stewart Publishing, Inc. (703) 354-8155

Initial Assessment of Respiratory Difficulty Presents a patient involved in a motor vehicle accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Intravenous Therapy Teaches intravenous therapy principles and techniques. *Compatible with:* FITNE Interactive System or IBM InfoWindow *Vendor:*

Fuld Institute for Technology in Nursing Education (614) 592-2511

IV Therapy/IV Solutions Reviews overall goals of IV therapy and the major types of IV solutions. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Managing the Experience of Labor and Delivery Simulates normal labor and delivery process beginning with admittance to the hospital of the laboring patient and her husband. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Mechanical Ventilators Provides brief overview of 10 mechanical ventilators *Compatible with:* IBM InfoWindow, Sony VIEW, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Motor Vehicle Trauma Simulation takes place in an emergency department, beginning with admission of a multiple trauma patient in hypovolemic shock. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Nursing Care of the Elderly Patient with COPD A case study simulation about a 73-year old man with COPD and pneumonia. *Compatible with:* IBM InfoWindow, FITNE, Sony VIEW, Visage *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

Nursing of the Cancer Patient with Compromised Immunity: The Nursing Process Simulates the five steps in the nursing process. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Obstetrics Simulation of the delivery of a baby in a rural community hospital. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Premenstrual Syndrome: A Clinical Manual Covers various areas of PMS from diagnosis and examination to diet and various drug therapies to assist in coping with it. *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Prevention of Occupational Exposure to the AIDS Virus Explains cause of AIDS, how HIV is transmitted, and how health care workers should protect themselves from exposure to the virus. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems, Online GL512, VAL *Vendor:* Professional Training Systems, Inc. (404) 872-9700

Shotgun Wounds to the Abdomen Presents opportunity to assess and manage a patient with shotgun wounds to the abdomen. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Sterile Technique at the Bedside Instructs health-care professionals in the steps for preparing and applying dressings and maintaining sterile techniques in patient care. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (800) 352-8293 (403) 256-1100

Urinary Catheterization Instructs health-care professionals in the preparation of the patient and the tray and proper catheterization techniques. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (800) 352-8293 (403) 256-1100

HEALTH SCIENCE

AIDS - An Educational Program Provides the essential facts about AIDS and how to avoid contracting the disease. *Compatible with:* IBM InfoWindow *Vendor:* Health Edutech, Inc. (612) 881-1926

The Birth Disc A visual database with over 9,000 images of childbirth from hospitals, birth centers, and home environments. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (612) 644-7802

Hormonal Contraceptions: Pills, Injections and Implants Covers various aspects of hormonal contraceptives *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Infection Control Provides basic information on how an infection is transmitted, how to isolate an infection, and how to prevent an infection from spreading. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems; Online GL512, VAL *Vendor:* Health Edutech, Inc. (612) 831-0445

Slice of Life III Over 26,000 still images drawn from various areas of medicine, dentistry and allied health education. *Compatible with:* IBM, Macintosh; Any player *Vendor:* University of Utah (801) 581-8052

STD: Sexually Transmitted Diseases Information Program Provides the facts about the eight most common sexually transmitted diseases. *Compatible with:* IBM InfoWindow *Vendor:* Health Edutech, Inc. (612) 831-0445

HEMATOLOGY

Basic Hematology Tutorial, drill and practice, and simulation program that utilizes the "Medical Applications Videodisc: Hematology 2nd Ed. (University of Washington) *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers Inc. (403) 462-6365

Introduction to Case Studies in Hematology A series of 20 case studies designed to acquaint students with basic problem-solving techniques involving cell identification and clinical correlations. *Compatible with:* Macintosh; Pioneer or Sony player *Vendor:* Edudisc, Inc (615) 373-2506

Laboratory Medicine Video Library: Atlas of Hematology Contains over 6,000 images forming a comprehensive library of hematologic findings which can be used for education, testing and reference. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Medical Applications Videodisc: Hematology, 2nd Edition Contains the entire American Society of Hematology morphology collection, the World Health Organization International Histologic Classification of Tumors, frames from the Western Universities' Physical Diagnosis Slide Bank, and extensive morphological study of acute leukemias, and the film "Red Cell Shapes" *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

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Acute Leukemia Morphology II Contains numerous exemplary peripheral blood smears, bone marrows and special stains for instruction and reference in the differentiation of acute leukemias. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

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Disorders of the Nervous System: Mentation Six patients are shown who demonstrate a variety of disorders of mentation. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Disorders of the Nervous System: Motor A compilation of material from a "visual glossary" collection of neurological dysfunction. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

International Veterinary Pathology Slide Bank, Ed. 4 Contains still frames of lesions from domestic, laboratory and wild animals from contributors in the U.S., Canada, and Europe. *Compatible with:* IBM-PC; Pioneer LDV-4200 *Vendor:* University of Georgia (404) 542-5837

Management of Heart Failure Covers the definitions and causes of heart failure, the signs and symptoms, pathophysiology and therapy. *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Pathophysiology of Shock/Pathophysiology of Cardiac Tamponade Looks at physiologic effects of shock and the body's compensatory responses to the syndrome. Provides 3 cases that demonstrate how cardiac tamponade presents itself and when to suspect tamponade. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

WILDLIFE MANAGEMENT

Yellowstone in Winter Provides insight into the work of Yellowstone's rangers in their management of wildlife. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

ZOOLOGY

Encyclopedia of Animals Eight discs covering mammals, birds, reptiles, insects, and marine life. *Compatible with:* Any player *Vendor:* Pioneer LDCA, Inc. (213) 835-6177

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 41

CLSE 1990 COLLEAGUE DIRECTORY - PART 1 42

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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CLSE 1990 COLLEAGUE DIRECTORY – PART 1

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is updated from the 1988-89 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 8 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 2 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 8 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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P.O. Box 51187
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or let us know via BITNET. NRCLSE's BITNET address is MODELL@UWALOCKE.

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

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Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

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CONTENTS

CLSE 1990 COLLEAGUE DIRECTORY – PART 2 49

CLSE 1990 COLLEAGUE DIRECTORY – PART 2

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1990 directory published last month. It is updated from the 1988-89 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 8 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 3 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 8 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

DESIGNING COMPUTER BASED TUTORIALS TO REINFORCE REASONING SKILLS 57
Harold I. Modell

CLSE 1990 COLLEAGUE DIRECTORY – PART 3 59

DESIGNING COMPUTER BASED TUTORIALS TO REINFORCE REASONING SKILLS

Harold I. Modell

National Resource for Computers in Life Science Education, Seattle, Washington

Ralph, in his recent description of biology courseware development for undergraduates, made the interesting observation that college students seem to prefer working with courseware having a tutorial rather than a simulation format.[4] What distinguishes a "tutorial" from a "simulation"? From a student's perspective, the "tutorial" is designed to impart specific information, while the simulation is designed to provide an environment in which the student "discovers" information. Perhaps the apparent preference for tutorials reflects the training that most students receive, beginning in high school and continuing through their undergraduate (and, in some cases, their graduate) careers. The entering medical student, for example, is a highly competitive individual whose learning skills have been directed toward achieving high scores on fact oriented, multiple choice examinations.[1,3] How many times have we heard students say, "Just tell me what I need to know to pass the exam!"

The traditional tutorial format does just that. Screens of information are presented, sometimes with color illustrations, animation or other attention-getting devices, followed by a series of questions. Based on the student response to the questions, additional information is presented, again in a manner that requires the student only to serve as a receptacle for the information.

A successful science curriculum should

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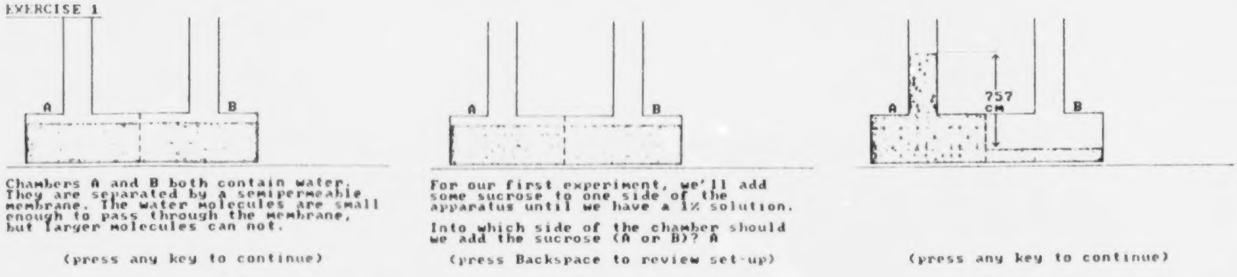

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EXERCISE 1

Chambers A and B both contain water.
They are separated by a semipermeable
membrane. The water molecules are small
enough to pass through the membrane,
but larger molecules can not.

(press any key to continue)
```

```
For our first experiment, we'll add
some sucrose to one side of the
apparatus until we have a 1% solution.

Into which side of the chamber should
we add the sucrose (A or B)? A

(press Backspace to review set-up)
```

```
(press any key to continue)
```

FIGURE 1. Series of screens from osmosis tutorial demonstrating the result of placing a 1% sucrose solution on one side of a semipermeable membrane. *Left Panel:* The experimental setup is explained. *Middle Panel:* The experiment is defined. *Right Panel:* The results of the experiment.

be directed toward helping the student develop investigative problem solving skills in addition to providing content information in a specific discipline and promoting a positive attitude toward science. In other words, the curriculum should deal with the scientific reasoning process as well as specific factual content. Computer-based learning materials, as part of such a curriculum, should also help students develop their reasoning skills.

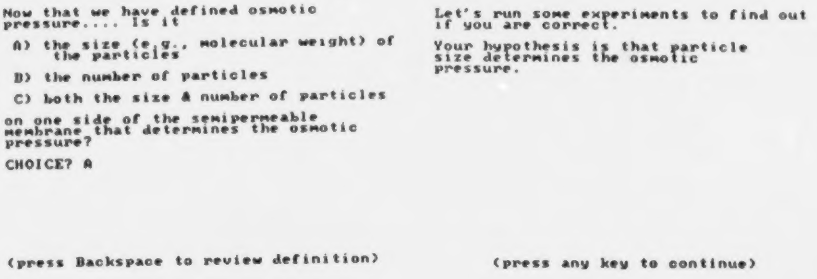
Traditional tutorials, however, seldom include a component designed to reinforce scientific reasoning or problem-solving skills. What options are available for including such a component? Some authors have incorporated simulations into teaching programs.[2,5] In these programs, students predict how the model will behave under a specific set of conditions. The model is then run, and descrepancies between the predictions and the actual model results are "discussed" with the student. The objective in these exercises is to help students develop the ability to analyze the behavior of complex systems.

Another approach is to reinforce the notion of posing and testing hypotheses by having the students test their answers (hypotheses) to the tutorial questions by running experiments. In this case, simulations are again incorporated into the tutorial. A recently developed tutorial dealing with osmotic pressure and osmotic relationships serves to illustrate this approach.

The tutorial begins with a demonstration of water movement in an osmometer after a 1% sucrose solution is added to one side of the semipermeable membrane (Figure 1). The next several screens ask the student what took place, explain the phenomenon, and define osmotic pressure. In asking the student what happened, the program begins to deal with the process of data gathering. The student is then asked whether the size of the particles, the number of particles, or both determine the osmotic pressure (Figure 2). No information regarding the answer to this question is presented in the previous screens. Thus, the student must form an hypothesis. In the example shown in Figure 2, the student has hypothesized that the size of the molecules is an important factor. The program then allows the student to test this hypothesis by providing a simulated osmometer with several choices for the molecules placed on one side of the osmometer membrane (Figure 3). Upon completing the experiment, the student may choose to run another experiment or choose to stop gathering data. If the student has not run at least two experiments, the program reminds him that there is insufficient data with only one experiment to test the proposed hypothesis. The student must then run a second experiment. If sufficient data have been gathered to test the hypothesis, the program asks if the data support the proposed hypothesis. The program response provided following the correct choice reinforces the observed results of the experiment rather than merely restating the correct answer.

PROS AND CONS

It is clear that this approach forces the



```
Now that we have defined osmotic
pressure.... Is it

 A) the size (e.g., molecular weight) of
     the particles

 B) the number of particles

 C) both the size & number of particles

on one side of the semipermeable
membrane that determines the osmotic
pressure?

CHOICE? A

(press Backspace to review definition)
```

```
Let's run some experiments to find out
if you are correct.

Your hypothesis is that particle
size determines the osmotic
pressure.

(press any key to continue)
```

FIGURE 2. The student is asked a question without the benefit of prior information from the tutorial. The answer becomes an hypothesis to be tested (see text).

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student to engage more actively in a scientific reasoning process than the more traditional format that presents information and reinforces that information by asking fact-based questions. It is also clear that this tutorial takes more time to complete than a traditional tutorial covering the same information. One must ask if this time is well spent. That is, will students using tutorials of this design begin applying the hypothesis posing-testing approach to other modes of study? It is doubtful that one tutorial would have such an impact. However, when a critical mass of tutorials with this design have been developed, studies can be designed to address this question.

CONCLUSION

We must, when designing tutorials, address the issue of whether such software should focus exclusively on content or should process also be an important consideration. If, as teachers, we feel that knowing how to deal with information is as important a lesson as the specific facts of a content area, we must do more to incorporate process into our teaching materials. Perhaps using "simulations" as a vehicle for assessing responses in "tutorials" will provide the added ingredient that truly distinguishes the computer tutorial from the high-tech textbook.

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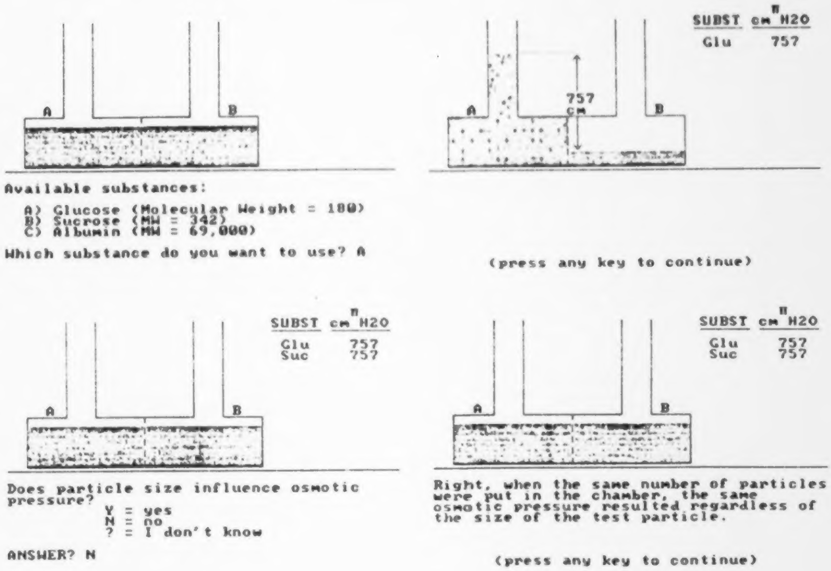

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Available substances:

  A) Glucose (Molecular Weight = 180)
  B) Sucrose (MW = 342)
  C) Albumin (MW = 69,000)

Which substance do you want to use? A
```

```
            π
SUBST    cm H2O
 Glu       757

(press any key to continue)
```

```
            π
SUBST    cm H2O
 Glu       757
 Suc       757

Does particle size influence osmotic
pressure?
          Y = yes
          N = no
          ? = I don't know

ANSWER? N
```

```
            π
SUBST    cm H2O
 Glu       757
 Suc       757

Right, when the same number of particles
were put in the chamber, the same
osmotic pressure resulted regardless of
the size of the test particle.

    (press any key to continue)
```

FIGURE 3. A series of screens presented in response to the student's hypothesis that particle size determines osmotic pressure. *Upper left:* The available experiments are defined. *Upper right:* The student has run an experiment with glucose. *Lower left:* The student has decided to stop collecting data and must make a conclusion based on the observed data. *Lower right:* The program reinforces the correct conclusion.

CLSE 1990 COLLEAGUE DIRECTORY – PART 3

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1990 directory published last month. It is updated from the 1988-89 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 8 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 8 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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or let us know via BITNET. NRCLSE's BITNET address is MODELL@UWALOCKE.

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

RESPONSIBILITY AND COPYRIGHT

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CONTENTS

ITEGRATED SYSTEMS FOR TESTING AND GRADING 65
Gloria H. Lombardi

KEEPING ABREAST OF THE LITERATURE 67

THE BULLETIN BOARD 69

ERRATUM 70

NRCLSE QUESTIONNAIRE 71

INTEGRATED SYSTEMS FOR TESTING AND GRADING

Gloria H. Lombardi
County College of Morris, Randolph, New Jersey

Personal computer based programs are available that permit test preparation, test delivery, test scoring, test analysis, and grade management. One or more of these functions such as test banks and test scoring have been previously available. Now, integrated software packages provide a fully automated system for test administration and grading. This allows an educator greater flexibility in test design and enhances the quality and reliability of the exam. In addition, the rapid access to the test data and the automation of record keeping frees the educator to do tasks that improve the quality of education.

The integrated systems manage all the details of producing a test in an interactive form. The educator creates a test from an existing test bank. The test is graded, the item analysis is updated, and the point valued is placed in the grade book within a very short time. The key can be corrected, the test rescored, and the roster updated in a few seconds.

There are several systems on the market that have these capabilities. These include the Par System, examSYSTEM, MicroTim, MicroPac, and the Examiner. These systems are user friendly, require

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no programming skills or sophisticated computer skills, and prompt the user at every step. There are other systems on the market. However, because this author is not familiar with them, they will not be included in this discussion.

There are features common to all integrated software packages for the components of test preparation, test delivery, test scoring, test analysis, and grade management. There are also features unique to specific packages. How does one decide on a package? Some considerations will be discussed including features of specific packages.

SYSTEM REQUIREMENTS

Only MicroPac can be purchased for the IBM or Apple. The rest are IBM compatible. All of the programs support popular optical scanners. Although speed of optical scanning is dependent on the hardware available, the convenience of having an automatic class roster and an automatic input of student responses generated is significant. If you give a test of more than 100 questions, you must consider a scanner model that reads two columns of answer forms (ParScore delivers 200 questions per test).

PRICE

The software package prices begin at about $1200 and range to over $2000. The Examiner is the most expensive of the packages. One needs to consider the price of the microcomputer, scanners (which begin at about $1300), answer forms, and special cards and cables necessary for the computer.

DOCUMENTATION

How well is the program described? Does it lend itself to staff and faculty training? The better the documentation, the easier it is to educate new staff and faculty. Are the developers available for consultation? Our institution uses the Par System which has excellent documentation and user support.

TEST PREPARATION

The preparation of tests can be streamlined through the use of test item banks. Test item banks are a collection of coded test items where the number of test items is larger than the number of items used in a test.

As educators, we want to use a variety of test questions. The software testing programs should allow matching, multiple choice, fill in the blank, true-false, and case presentations. You might want to consider the inclusion of graphics into items. The more restrictive the format, the least likely the software package will be accepted by the faculty.

What means does the program have of entering test questions? How easy is it? How do you make changes? Is the software compatible with other word processors? Is there a built-in editor?

Test security needs to be considered especially when building a very large pool of items over an extended period of time. The Examiner meets the most stringent security requirements. It is protected by passwords, and all the items are encrypted when stored on disk.

The method of coding, selection of items, and type of items to include in a test varies greatly from program to program. I would suggest conducting a needs analysis of the potential users, and then looking for the program that best meets their needs. MicroTim includes a biochemistry item bank of 7,000 questions.

TEST DELIVERY

Once the instructor develops a test, it can be delivered to the student via computer (on-line testing), or in printed form (off-line testing). Careful consideration of available hardware must be taken into account before the faculty makes a decision to test students on-line. The Par System and the Examiner allow for on-line testing. For off-line testing, the software package should be flexible to meet the unique needs of all faculty. The features of the test generating package should be evaluated to ensure that directions, titles, graphics, and test format all conform to the desired style of the instructor.

ParScore allows "on the spot" on-line correction of errors and prints an error log for later reference. The student responses are also recorded. This is an especially important feature if a student tries to alter the answer sheet.

TEST ANALYSIS

After scoring a test, the results can be used for item analysis. A statistical analysis is also used to analyze the results of the test. All the programs put the results of an item analysis directly into the test item bank. Each program differs in the analysis of the test. ParScore includes the mean, median, standard deviation, and the KR-20 reliability ratio in the analysis of the test. In ExamSystem, all classes taking the same test can be combined for statistical summary reports.

GRADE MANAGEMENT

Once a test has been delivered, student grades may be accumulated using several methods. Does the software package provide for test grade averaging, ranking and so forth? In the examSystem, the grade book can handle up to 90 different scores per student per class. Grade criteria can be changed at any time. Letter grades are automatically assigned based upon the instructor's grading criteria.

FEEDBACK OPTIONS

Does the software provide student feedback to each question? MicroTim allows automatic display of instructor generated error explanation upon entry of an incorrect student response. It also allows student feedback to the instructor about particular questions through a comment facility.

The interactive microcomputer software systems offer a faculty a decision making tool for flexible test design and construction, provide rapid access to test data, and are a tremendous savings in faculty time. I feel that the time saved in test construction, and the improved quality of the test, as well as the ability to track students far outweighs the costs incurred by the system.

VENDORS

Examiner
Media Computer Enterprises, Ltd.
880 Sibley Highway, Suite 102
Mendota Heights, MN 55118
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ExamSystems
National Computer Systems
11000 Prarie Lakes Drive
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Minneapolis, MN 55440
(800) 447-3269

MicroPac
MicroSystems Software, Ltd.
Educational Systems
P.O. Box 3123
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MicroTim
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Par System
Economic Research Inc
P.O. Box 7200
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(714) 641-3955

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WANTED

– Feedback –

- Is CLSE meeting your needs?
- Have important topic areas been overlooked?
- Should more regular features (eg, Keeping Abreast of the Literature) be added?

To serve you best, we need your input. Please send comments and criticism to:

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THE BULLETIN BOARD

The Bulletin Board is published periodically to inform readers of upcoming meetings of interest. If you know of meetings, symposia, continuing education courses, etc, of interest to life science educators, and they do not appear in The Bulletin Board, please let us know. Send pertinent information to:

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OCTOBER 2-3, 1990. EdNET 90: The Educational Technology and Telecommunications Markets Conference. Washington, D.C.

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Suite 600
707 Skokie Boulevard
Northbrook, IL 60062
(708) 205-4390

OCTOBER 4-6, 1990. "Information Systems and Technology for the 1990's" Annual conference, Association for Computer Educators. Minneapolis, MN

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Minot, ND 58701
(701) 857-3110

OCTOBER 9-11, 1990. 3rd Annual Multimedia Expo. San Francisco, Ca.

Contact:

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110 Greene St. #703
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(212) 226-4141

OCTOBER 14-17, 1990. EDUCOM '90. Preparing for the renaissance.

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P.O. Box 364
Princeton, NJ 08540

OCTOBER 24, 1990. Videoconference - Educational Technology for Nursing: A Solution for Today's Problems. Cupertino, CA

Contact:

Gladys Penner, Teleconference Coordinator
De Anza College Television Center
Cupertino, CA 95014
(408) 864-8300

OCTOBER 28 - NOVEMBER 1, 1990. 32nd Annual ADCIS Conference: Restructuring Training and Education Through Technology. San Diego, CA

Contact:

ADCIS International Headquarters
229 Ramseyer Hall
29 West Woodruff Avenue
Columbus, OH 43210-1177
(614) 292-4324

November 7-11, 1990. IFER Workshop on Alternatives in Education. Houston, TX

Contact:

International Foundation for Ethical Research
53 West Jackson Blvd.
Suite 1542
Chicago, IL 60604
(312) 427-6025

NOVEMBER 15-16, 1990. Western Educational Computing Conference - "The 90's: The Decade for Transition", Irvine, CA

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JANUARY 18-20, 1991. Association of Biologists in Computing, Los Angeles, CA

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(213) 343-2056

FEBRUARY 5-8, 1991. 11th Annual Florida Educational Technology Conference. Tampa, FL

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Suite B1-54
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FEBRUARY 20-22, 1991. Fifth Annual Conference - Learning Technology in the Health Care Sciences and Eighth Annual Conference - Interactive Instruction Delivery. Orlando, FL

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ERRATUM

Modell, Harold I: Designing computer based tutorials to reinforce reasoning skills. *Computers in Life Science Education* 7(8):57-59, 1990.

The citation of references in the body of the article do not correspond to the order in which the references are listed. The following list properly identifies the references as cited.

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NATIONAL RESOURCE FOR COMPUTERS IN LIFE SCIENCE EDUCATION QUESTIONNAIRE

To be effective in our effort to promote a communication network among life science educators interested in using computers in their educational efforts, ***we need your help.*** If you have not completed our questionnaire this year, please take a few moments to complete the questionnaire below and return it to the following address:

Harold Modell, Ph.D.
NRCLSE
P.O. Box 51187
Seattle, Washington 98115

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Address: ______________________________

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Phone: ______________________ BITNET: ______________________

What content areas do you teach? ______________________________

What student population(s) do you serve? (Please check appropriate categories)

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____ Allied Health ____ Dental ____ Veterinary

____ Other (please specify) ______________________

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If yes:

How many years have you used the computer in this way? ________

What kind of equipment are you using?

Have you written any software for use in your teaching efforts? ___ Yes ___ No

What commercially available software have you found useful?

Would you be willing to help critique software for peers? ___ Yes ___ No

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

A COMPARISON, FOR TEACHING PURPOSES, OF THREE DATA-ACQUISITION SYSTEMS FOR THE MACINTOSH 73
Harold D. Swanson

A COMPARISON, FOR TEACHING PURPOSES OF THREE DATA-ACQUISITION SYSTEMS FOR THE MACINTOSH

Harold D. Swanson
Biology Department, Drake University, Des Moines, Iowa

As the first phase of studying how computers might be used for data acquisition in teaching laboratories of the Biology Department of Drake University (and as a necessary prelude to purchasing a system for doing that), I conducted a "hands-on" comparison of two systems that seemed especially suited for this purpose, coupled with a more limited comparison of a third system.

Each of the three systems proved to have many virtues, but they differed in several important respects and in how suitable we judged them to be for our department and program. One widely advertised and much acclaimed system, LabVIEW software and accompanying hardware from National Instruments, we judged the most versatile and powerful but far too difficulty to learn to fit our needs. A less well-known system, Analog Connection WorkBench software and accompanying hardware from Strawberry Tree Computers, was judged easy to learn and use and powerful enough for all our anticipated uses; it was the one

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chosen for purchase. The system seen in less detail, MacLab hardware and software from World Precision Instruments, was judged to be the one best preadapted for routine physiological recording and to have the easiest instruction manual to use. But it is so much less powerful and flexible than the other two programs that we judged it less suitable for our immediate project of investigating the whole range of possible applications of computers to teaching laboratories.

The conditions and results of the comparison are presented here in some detail, in the hope they might aid other departments in judging which of the systems is most likely to fit their particular uses.

BACKGROUND

Data from instruments can be read directly into computers to be stored, processed, and graphed. Signals from the computer can be used to control the experimental procedures and measuring instruments. Both these functions of computers have become increasingly important in research and testing laboratories, usually with expensive computers dedicated to specific tasks.[4,5] Such technology, however, is rare in physiological and other biological teaching laboratories, both because of expense and because of the difficulty of making appropriate hardware connections and writing the necessary programs.

All these barriers to the use of computers in teaching laboratories — for controlling instruments and acquiring data from them— are now becoming much less formidable. Powerful and versatile systems are now available for these purposes, using the same relatively inexpensive microcomputers used for other purposes. Several of these systems are advertised as being user friendly, requiring little electronic knowledge and no familiarity with programming languages.[2,3,7] Most of these systems present menus for choices about their operation.

THE CONTESTANTS

The claim to be user friendly is made with special strength by the two systems for the Macintosh that were the primary subjects of my comparison. With both of them, the details of operation are programmed by means of icons, similar to those familiar to users of the Macintosh. These icons can be combined in flowcharts to create unique programs. In addition, many choices are presented in menus. The two systems include much the same sorts of hardware and software. The hardware consists of a board inserted in the computer and fastened by a cable to an external connection block, which has screw-terminals accepting wires from any external source. The software includes "drivers" for the board (invisible to the unsophisticated user) and the iconic programming language.

The better known system is from National Instruments of Austin, TX; the programming language is called LabVIEW. It may be used either with one of the National Instruments boards or with boards supplied by certain other companies.[8] (I will, somewhat inaccurately, refer to the whole package tested, both hardware and software, as Labview.)

Less well publicized is the system supplied by Strawberry Tree of Sunnyvale, CA, whose software is called Analog Connection WorkBench. It supports only the boards from Strawberry Tree. (I will call the whole system Workbench.)

These systems were compared directly with each other and less directly with MacLab from World Precision Instruments (WPI) of New Haven, CT. This was seen in a demonstration by a WPI representative, in a "demo-disk," and in a colleague's laboratory. MacLab is menu driven; yet it cannot be programmed in the sense the other systems can be (although many options are presented) and does not have much capability of controlling instruments (although this is promised for the future). It is mentioned in this comparative study because, in conspicuous contrast to the two systems being primarily considered, it was designed specifically to fit the needs and expectations of physiologists and biologists and is accompanied by instructions biologists have little trouble reading.

BASIS OF COMPARISON

The three systems were compared on the basis of versatility, suitability, and feasibility; they showed differences with regard to all three.

Versatility was judged with respect to possible uses in the Drake Biology Department, on the basis of trials of a few of the possible applications, and of information in the instruction manuals supplied with the various systems. Our student laboratories include a variety of measuring instruments, all of which generate data that might usefully be analyzed with the computer. Most obviously, the laboratories in physiology, cell biology, and occasionally in general biology measure quantities that change in minutes or fractions of a second, including both biopotentials and physiological actions detected by transducers. In these and other areas of study, various instruments need to be turned on and off or triggered to perform particular operations, all at particular times and under particular circumstances. The need for power and versatility in student laboratories is increasing for our department as we increasingly involved undergraduate students in research activities.

Suitability was judged by comparing the capabilities of the hardware and software (according to specifications and descriptions supplied by the manufacturers) with what were assumed to be the most difficult uses to which we might expect to put them, and by testing a few of these challenging applications. the three areas of greatest concern were frequency response (how fast changing a signal could be faithfully recorded), sensitivity (how small a voltage change could be detected), and data manipulation (how many of the desired analyses of data and comparisons between sets of data could be performed and how easily). Feasibility was a judgement of how user friendly the systems really are — whether it will be practical to try to use them for our purposes. This judgement was based on my personal experience in the comparison project. Answers to questions of feasibility of such systems are very much a function of the individual people who would actually use them. Can I, as the department member first involved in trying to use the systems, succeed in doing so in the time available? Can I expect other members of the department, with a little bit of help from me, to develop and apply the necessary skill to use the system in their laboratories? Will our students be able to do some of their own

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programming for their own projects?

My personal capabilities for learning to use such systems are probably not unusual among physiologists and biologists. I have long used, and occasionally tinkered with, a variety of instruments including physiological recorders. Many years ago I took two coursed in physics and one in electronics, and I have taken (but not used) three courses in simple computer programming. Just by using manuals and occasionally asking questions of the experts, I have taught myself to do what I wanted to do with the Statistical Package for the Social Sciences, and with Microsoft EXCEL, as well as learning to use three word processing programs on three different computers. Thus if I can use these data-acquisition systems, most biologists can. If I cannot do so without extensive training, many others cannot either!

Just on the basis of catalog descriptions and of the reviews that were available,[8,9] it seemed fairly evident that the three systems constitute a progressive series in both power and ease of use, with MacLab the least powerful and easiest to use and Labview the most powerful and the most difficult to use. But catalogs and reviews can be misleading. Some reviews in trade magazines are even written by representatives of the company promoting the product[1] or are based heavily on the specifications furnished by various suppliers. Even the objective reviews of new technology, generally written by engineers, may not be realistic about the suitability of a product for the final user.

The purposes of this comparison project were, first, to determine whether the published comparative descriptions of these three systems are correct, and second, to assess how critical are the differences among these systems in power and ease of use. The conclusion was that the comparative series is correct and that the differences can be critical.

CONDITIONS OF THE TEST

Representatives of Strawberry Tree and of National Instruments allowed me to borrow hardware, software, and manuals for two months in the summer of 1989. The two systems were installed in a Macintosh II computers with a 20Mb hard disk, furnished by a grant from Drake University Computer Intensive University Project. I worked principally from the manuals but made a few telephone calls for programming advice from the representative of the two companies. (Both Strawberry Tree and National Instruments supplied competent, quick, courteous, and imaginative advice by telephone.) The MacLab system was demonstrated to several faculty members a couple of months before the comparative study began; a demonstration disk and a manual continue to be available for reference, and a colleague in a neighboring department has just begun working with MacLab.

The two systems, Labview and Workbench, were compared by setting up each one to accomplish two tasks. The first task was to receive an electrocardiograph signal, display it in real time, and record it for more detailed computer analysis. The second task was to supply power to a force transducer, receive, display, and record the signal, and facilitate zeroing and calibration. The capabilities required by these two tasks are basic for physiological teaching laboratories and resemble the capabilities of popular physiological recorders (plus the ability to record data in a form suitable for direct analysis using the computer). In addition, the capabilities tested broadly overlap with those of MacLab, making that further comparison possible.

It was originally intended that Labview and Workbench would be studied in an evenhanded way, but there came to be two expectations to that policy. First, Labview was installed and demonstrated by a company representative, who used it to program a "virtual instrument" (a software program controlling acquisition and use of data) for displaying and recording electrocardiograms (ECGs). (I later modified this virtual instrument for use with the force transducer.) Workbench, however, was shipped to me, and I installed it and started using it on my own. The second exception was that I spent about twice as much time during the trial period working of Labview as with Workbench.

COMPARATIVE DESCRIPTIONS

Hardware

The differences in hardware between Labview and Workbench are not critical, but the MacLab hardware is significantly different from the others.

The particular National Instruments (Labview) and Stawberry Tree (Workbench) data acquisition boards that were compared are very similar in capabilities. Both provide for eight channels of analog input (recording of quantitative electrical signals), and two channels of analog output [controllable direct current (DC) voltage up to ~10 V]. Each also offers eight channels of digital output or input (pulses that trip switches or signal the state of switches). The one important difference between the two is that the Labview board (NB-MIO-16L-25) is described as having a maximum sampling rate of 40 kHz on a single channel, whereas the Workbench board (ACM2-12) can sample at a rate of only 10 kHz. This difference is critical for recording the shape of a nerve impulse. (Workbench promises a new board soon, capable of more than 40 KHz.) (For recording on multiple channels simultaneously, the sampling frequencies possible may be reduced by as much as a factor of five.)

Either board is connected by cable to an external panel with screw-terminals for wires to and from laboratory instruments. The Labview connection panel is a little easier to connect wires to but is not as well labeled as the Workbench panel; labels facilitate using the right terminal. The Workbench panel offers 5, 12, and 6.9-V fixed power sources, the Labview panel only 5 V. The 5-V source is intended for use with the digital signaling system, but can be used to supply excitation voltage to a bridge-type transducer, as can the 12-V source. The 6.9-V supply in the Workbench board is described as regulated, to give an especially steady excitation. But the manuals for both systems warn that the power sources available on the connection panel might not supply a full eight transducers at once — perhaps only two or three. (With the 12-V supply from the Workbench board, transducers might be connected both in series and in parallel, to a fairly large total, depending on their resistances and voltage requirements.) Thus for multiple transducers, it may be necessary to use an external battery or power supply anyway; so the differences between connec-

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tion panels are not critical.

In contrast to these two systems, MacLab has no internal board for the computer; the hardware is external, with connections by way of the serial port. (this means that data may be acquired using a Mac Plus; a Mac SE or Mac II is not required, but the hardware is much more expensive.) The external hardware includes a power supply for transducers and circuitry for balancing, zeroing, and calibrating them, preamplifiers for magnifying weak signals, and a stimulator. The frequency response on one channel is 40 kHz, sufficient for nerve impulses. There are no provisions for digital input or output for us in controlling instruments, although the stimulator output can be used for some kinds of control. The model I have seen provides only four channels of analog input, one channel of analog output, and no digital input or output (compared with 8,2, and 8, respectively, for the other two systems.) A newly available version offers eight channels of analog input, but still no digital capability.

Software

Both Labview and Workbench can be described as programming languages that use Macintosh icons instead of written commands. The programmer selects icons from a menu and arranges and connects them by "wires" into a flowchart. The software instantly creates a program that carries out the operations indicated. The flowchart remains as an easily readable documentation of how the program works. National Instruments uses the term "virtual instrument" for these programs and for their visual representation as flowcharts. LabVIEW is an acronym for Laboratory Virtual Instrument Engineering Workbench. For some particular instruments, National Instruments offers prewritten virtual instruments in which the appearance of the computer screen closely mimicks the front panel of the instrument being controlled and monitored. In this discussion, I will occasionally use the term "virtual instrument" for flowchart programs of either system.

For building a virtual instrument, there are icons representing particular analog input channels (for receiving electrical signals that may vary in any pattern), analog output channels (for emitting electrical signals in some pattern), and digital input and output channels (for signals that are either on or off). Each of these external icons represents one of the sets of screw-terminals on the external panel. There are also internal icons for generating values or pulses, turning parts of the program on or off, and performing a great variety of mathematical and logical operations on signals coming to them. Finally, there are icons for logging data onto disk and for displaying it in meters or charts.

Once the programmer has in mind which icons to connect in what order, this is easily accomplished with either Labview or Workbench, using the mouse. A particular setup might take 15 minutes to construct with Labview as opposed to only 5 minutes with Workbench, because in Labview the mouse must be changed into particular "tools", and because "wires" must be removed from them before icons can be shifted. But the result is a somewhat more readable flowchart. Similar tradeoffs without great advantage to either system can be noted with regard to many other small differences in the styles of the flowcharts of Labview and Workbench.

The really critical difference between Labview and Workbench is in the number of different icons. Workbench has only 14 (although some of them represent a great variety of functions that can be chosen), whereas Labview offers many more, many hundreds, often with multiple options. A large fraction of the Labview icons perform functions that can be duplicated by combining two or more Workbench icons; another large fraction perform functions and manipulations of data that cannot be so duplicated with Workbench.

Its many functions make Labview not only a data-acquisition system but a powerful data-processing program as well. It can perform not only algebraic manipulations but sophisticated statistical analysis and several kinds of Fourier analysis, among others. It appears that most often these analyses would be performed on already-collected data, but some might be important on-line for changing, automatically, some aspect of the whole setup.

Workbench, in comparison, has limited data-processing capabilities. Many algebraic functions or two streams of data may be calculated and then logged, displayed, or used to control something, but statistical and other analyses are hardly represented. Thus any detailed analysis of data acquired from Workbench requires logging the data and entering them into a spreadsheet, statistical, or graphics program.

Any analysis of recorded data that is done by a data-acquisition program can be done equally well by one of these other programs, so the critical importance of capabilities for data analysis concerns what can be done on-line. The first important reason for a data-acquisition program to include some processing abilities (as both Labview and Workbench do) is to give immediate display of the derived output of some instruments, for immediate use. The second reason, potentially much more important, to use the results of calculations to turn on logging or fast recording, to prompt the sending of a digital control pulse, or to control the response to an incoming signal pulse. Labview offers a greater variety of calculations that can be used for such purposes.

The problem with having multiple icons for programming and multiple choices for calculations, as Labview does, is that there is so much to learn before a virtual instrument can be constructed. Although the manual describes each icon, it is difficult to know which description to look up, and in what sequence the descriptions must be studies to be intelligible. Furthermore, the manual is uneven in its treatment. It gives a good description of how to manipulate and "wire" icons on the screen and how to use simple calculation icons to achieve a result. However, it gives very little guidance in the use of the more advances features, i.e., multiple icons for controlling analog input and output, and "structures" for defining the sequence or duration of particular operations. Consequently, it is just not practical to use the manual to teach oneself to use Labview to construct a variety of virtual instruments. In sharp contrast, on can easily learn to build virtual instruments with Workbench, using just the manual.

Feasibility: hands-on experience

These opinions are based on and illustrated by my hands-on experience during the summer of 1989. Workbench manual in hand, I created, in a few hours, a virtual instrument that displayed my ECG very well, and I added a feature that kept the mean voltage at zero. In a few days, I modified and augmented this into a virtual instrument that supplied excitation to a force transducer and displayed its output, that corrected the output to zero when no load was applied, and that calibrated the virtual instrument to give a display in grams. At first, I had to type in values (generated by the instrument) for zeroing and calibrating, but in another day's work I modified the virtual instrument, so that when I pressed a button (with the mouse) when there was no load, the instrument zeroed itself; with a 2-g standard added, I pressed another button, and the instrument calibrated itself. I am now confident that I can learn to perform a greater variety of such control and data manipulations and can show my colleagues and students, in minutes or hours, how to begin to do this for themselves.

My experience with Labview was different. The National Instruments representative had used Labview to create for me a couple of virtual instruments for displaying ECG (it took him a number of minutes). Using the manual, I worked for several weeks to modify and augment one of these to display calibrated data from a force transducer. For 2 weeks I was frustrated as I have ever been; then I began to understand how to do such simple things and construct a quite satisfactory virtual instrument that I could zero and calibrate by typing values from a display into an icon. I spent a week or two trying to duplicate my Workbench provision for automatic zeroing and calibrating, but I was not successful. (I think I was pretty close when I decided to quit!) I would guess that if I spent 2 or 3 months doing nothing but read the manual and tinker with Labview, I could learn to use it quite effectively (and so could some other biologist). But it would not be an efficient thing to do (and might not yield a sane biologist!)

National Instruments offers 3-day training courses in Labview for about $500 per person; in retrospect, it would have been wise for me to include a Labview training course in my evaluation project. It is my judgement that a department should plan to use Labview only if it can provide such training for everyone who is expected to create new virtual instruments. I suspect that even with the training it would require quite a bit of practice to become and remain proficient in Labview. Given the slim budget of our department and the only tentative interest on the part of some members who might profit from a data-acquisition system, I was not able to recommend that we choose a system that requires so much training for its users.

How much did our department lose by not choosing Labview, the more powerful system? I cannot give a clear answer to that question. For data that have previously been gathered, Labview has many provisions not provided by Workbench for processing, comparing, and displaying them. However, the most important of these processing capabilities are otherwise available. Faculty and students at Drake University have Microsoft EXCEL available to them; this or another spreadsheet program can perform most of the manipulation, statistical analysis, and graphing in which we might be interested. Also, quite a number of the functions of which Labview is capable, fast Fourier analysis is an example, are more commonly used by physicists and engineers than by physiologists and biologists.

The third system, MacLab is, again, quite different. There is no programming (iconic or otherwise) to perform special tasks, although there is a great deal of choice about such things as amplification, calibration, sampling rate, and display. MacLab can perform several analyses of data, different but somewhat comparable to the capabilities of Workbench, but not approaching the variety of Labview. MacLab has several built-in functions — difficult or perhaps impossible to duplicate with Labview or Workbench — that a physiologist might find very attractive. Most notably, one can review a complicated curve on the screen, use the mouse to select a portion of it, display that portion in greater detail, and store just that portion on spreadsheet form. Also, if one points with the mouse to a particular point on a curve on the screen, the program will display the numerical value (to several decimal places) of the coordinates at that point, and if desired, the slope. Other provisions similarly mimic and facilitate the kinds of examination commonly made of data gathered with physiological recorders and oscilloscopes. Data is logged to disk for further analysis on a spreadsheet just as with the other two systems. If one wishers only to duplicate (at a saving) the actions of physiological recorders and simple oscilloscopes, to add a few new analyses, and to record data for computer processing, MacLab is the easy way to do it. Its manuals are detailed and well written, specifically for physiologists and their projects. But one must then settle for the (very nice) options that MacLab offers, and for only a very limited ability to control instruments. (World Precision Instruments now offers a software program, WaveEdit, that costs $400 and is said to work on any data in spreadsheet form and that includes many of MacLab's abilities to display data in graphic form for closer examination, selection, and storage. This capability may prove useful whatever system is used to acquire the data.)

Speed

All three systems can record data for a limited period in a "fast mode", with sampling frequency limited only by the hardware: 40 kHz for Labview and MacLab, 10 kHz for Workbench. I presume they all function as advertised. (I have used this capability of Workbench, quite successfully, to record, calculate, and eventually display the "loop" of electrical axis of the heart.)

During normal (as opposed to fast operation, however, the three systems differ significantly in "cycle time" and, hence, in how faithfully any rapid changes of a signal are displayed or recorded. The cycle time is a function of how fast the software performs various calculations and adjustments. The effect of cycle time can be illustrated by my experience with displaying the ECG. A virtual instrument made with Workbench displayed an acceptable ECG on a continuous basis. Similarly, one of the standard options of MacLab did this at least as well.

By contrast, the similar Labview virtual instrument displayed ongoing ECG very imperfectly and inaccurately, not much more than an occasional blip on the line. This was not due to any deficiencies in the virtual instrument made for me by the National Instruments representative; rather, it was because Labview is very slow and cannot handle such rapidly changing signals. To understand this difference in effective speed, I compared cycle time (time between successive sampling of data) for my Workbench and Labview virtual instruments that zeroed and calibrated the output from a force transducer. The rival setups were nearly identical in number of icons and equally straightforward. However, the cycle time of the Workbench instrument was only 35 ms, whereas that of the Labview instrument was 1.1 s, nearly 30 times as long. It was only by accident that a sampling rate in this range would detect any indication of an ECG pattern! (This shows why, for rapidly changing data, the analytical and processing power of Labview cannot be used on line and must be applied only to data already recorded. This applies to complicated Workbench manipulations as well.)

Inventing new capabilities

The Workbench literature includes fairly detailed instructions to programmers who wish to create new functions to use; such functions become new options within the calculation icon. But programming such new functions requires skill with a programming language. Thus the level of difficulty of using Workbench increases abruptly form "iconic programming" to "new functions."

Although MacLab does not have a provision for simple iconic programming, the company offers (at a cost of $595) a programming system using Pascal for creating new applications.

This is where Labview is clearly superior to the other two systems. All the new functions one might need are already available, symbolized by icons. Although it is more difficult to learn and to use for simple applications, Labview would seem to be no more difficult for complicated applications than for simple ones.

Like everything else in the computer world, data-acquisition systems are changing rapidly. All three companies considered here have recent or expected innovations in both hardware and software. National Instruments' newest catalog offers new, less expensive boards for classroom use. Strawberry Tree says a board with higher frequency response is imminent. World Precisions Instruments now offers eight channels, and, eventually, digital control.

It would be comparatively simple for both National Instruments and Strawberry Tree to make their systems far more attractive to physiologists and biologists than they are now. They could create half a dozen virtual instruments to gather the kinds of data most commonly of interest to physiologists and biologists, supply these virtual instruments on a disk, and accompany them with detailed instructions for their use. The virtual instruments would not need to be much more sophisticated than those I made last summer. Given such aids, new users could begin to use LabVIEW or Analog Connection Workbench immediately. Some users would never need to create new virtual instruments for themselves; these would fill all their needs. Those who wanted innovations could easily copy and then modify these standard virtual instruments or follow their patterns in creating new ones.

Costs

Any of these systems could replace, at considerably lower cost, most or all of the functions of standard physiological recorders and simple oscilloscopes, while adding the capability of reading data directly into computers for further detailed analysis. Comparative cost among the three systems depends not only on the list prices, but also on particular components chosen and any educational discounts that may be available.

The list prices (in US dollars) for the configurations compared in this article are as follows, based on the most recent price lists I was given.

National Instruments:

Board	1,195
Connector	150
Labview	1,995
Total	3,340

Strawberry Tree Computers:

Board	1,190
Connector	179
Workbench	995
Total	2,364

(The cost of a spreadsheet program for analyzing the data must be added to this.)

World Precision Instruments:

MacLab	2,925
MacBridge	975
Total	3,900

(As with Workbench, detailed data analysis requires additional software.)

The most expensive component of any of these systems is the computer itself, preferably with a hard disk, if any amount of data is to be collected. That is where WPIs MacLab has the advantage, since it can be used with any Macintosh. The particular boards for Labview and Workbench whose properties have been compared here are for a (relatively expensive) Mac II. For multiple use in a student laboratory, it would be preferable to be able to use the same iconic programming capabilities in a (less expensive) Mac SE (the smallest Macintosh that will accept an internal board.) Both companies make boards for the SE that might be suitable for student use, but with limitations.

National Instruments offers the Lab-SE board for only $595. It has the same numbers of analog input, analog output, and digital input-output (I/O) lines as the board for the Mac II, and an even faster sampling rate of analog input, i.e., 125 kHz. But the analog input channels are single-ended instead of differential. It is my understanding that it is either difficult or impossible to use single-ended channels for signals from bridge-type transducers, a major part of physiological instrumentation. So their suitability is doubtful. (A representative of National Instruments informs me that it would be possible to construct a virtual instrument that converted the 8 single-ended channels into 4 differential ones. If that virtual instrument is supplied, the Lab-SE board would be much more suitable for use in physiology laboratories.)

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Stawberry Tree Computers offers the ACSE-12-8 (for the SE) for only $695. Its analog input channels and digital I/O channels are like those of the board for the Mac II. But the SE board does not support any analog output channels, a moderately serious deficiency. The use of analog output to supply excitation current for bridge transducers can easily be replaced by connecting these to the several fixed-voltage supplies present on the connecting panel. Uses of analog output for providing stimulating impulses at programmed times can probably be replaced by using an external power supply (such as a stimulator) and regulating it by way of the digital output. I suspect that these substitutions would prove practical in student laboratories, so that this board would be useful.

COMPARATIVE SUMMARY

All three systems were judged suitable for use in student laboratories; they will gather the kinds of data we are likely to want for the kinds of experiments routinely done. Each system, however, has limitations. The MacLab system cannot be used for digital control of instruments, which may be important for some teaching purposes. The suitability of Workbench for recording nerve impulses depends on a new board with higher frequency response. The Labview system does not work well for displaying a fast signal on-line. But it is the only one of the three capable, by itself, of doing nearly all the kinds of data manipulation and analysis which might be of interest; the other systems must be supplemented with other analytical software such as a spreadsheet.

The versatility of both Labview and Workbench was judged quite sufficient for all our anticipated needs (although that of Labview is quite a bit greater). The versatility of MacLab is much less than that of the other two: this difference was decisive in eliminating it from consideration for our immediate purposes of investigating all possible applications.

The feasibility (ease of use) also differed decisively. MacLab is much superior in this regard, whereas Workbench requires more effort than MacLab but is still quite acceptable. By contrast, it would be feasible to use the Labview system only if all those people putting it into operation took a training course in its use. On this basis, Labview was eliminated from considerations for our department at the present time.

USING COMPUTERS IN TEACHING LABORATORIES

It has now become truly feasible for physiologists and other biologists — with no special training in either electronics or computer programming — to use computers in teaching laboratories for acquiring as well as manipulating data. The three systems reviewed here can, to different degree, make such use feasible. Just what applications of this technology are practical, and how much these applications can improve the educational process, are matters still to be determined. Our department will be considering these questions intently in the near future and probably for a long time to come. Other departments will need to make the same judgements. The following possible uses are among those that need to be evaluated.

Recording data for later analysis

Data recorded directly into a computer are stored in a form directly accessible to spreadsheet and statistical programs, eliminating the necessity of keying in the data. For isolated values, this is of limited value, except that the values are presented in numerical form and need not be estimated from a tracing. The real utility comes of there is interest in a continuous stream of data or a whole sequence of sampling points or if the computer can be used to pick out the points of interest from such a stream or series. Some laboratory exercises may be devised or improved by taking advantage of these capabilities. All three systems reviewed here record data quite satisfactorily, but only Labview provides, of itself, a wide choice of further analyses.

Constructing physiological simulations

Any physiological process or control system that might be simulated with an electromechanical model can be even more easily simulated with a virtual instrument constructed using Workbench or Labview. Kiel and Shepherd, [6] using Labview, have published a simulations of several cardiovascular functions. Constructing such simulations is much easier using iconic programming than with conventional programming languages. The available options for display will probably not allow the simulations to appear either realistic or esthetic, but the available labeling capabilities can allow them to be quite informative. With Workbench (but not with Labview) it would be suitable to assign the construction of simple simulations as student exercises.

Enhancing and replacing instruments

Any device that emits an electrical signal in proportion to some quantity of biological interest can be connected to the computer with one of these systems reviewed here and be zeroed and calibrated. The data can be sampled and recorded continuously or at chosen intervals or circumstances, all with minimal difficulty and at no expense after the initial investment. This means that it may be cost effective to replace physiological recorders (and some associated equipment such as preamplifiers and stimulators) with computer systems. Beyond this, it is possible to take antiquated but still functional measuring instruments already available in a teaching laboratory and, by connecting them to a computer system, turn them into modern "smart" instruments capable of various calculations and enhancements. The Labview and Workbench systems lend themselves well to this kind of use. With Workbench, it would even be possible to have students plan and program the enhancements to be made with certain instruments; this would be a way of assuring that the students understand what their instruments are doing. In contrast, MacLab can receive, amplify, and record the output from instruments, but the connection cannot be as thoroughly customized as with the other two systems.

Automating laboratory manipulations and data gathering

Many experiments that might be of interest in a teaching laboratory require several hours of elapsed time, during which conditions are manipulated and data is gathered. Such an experiment cannot be fitted into a 2- or 3-h laboratory session,

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and there are often many practical difficulties to having even a few of the students work during the extended period necessary. Such computer systems as those described here may make such extended experiments more feasible. Many experimental manipulations (turning lights on or off, adding some ingredient to a solution, even adjusting the tension of a connection) can be performed by electronically controlled switches, pumps, or motors. With computer systems (Labview and Workbench) that can send and receive digital signals, it seems as though it would be relatively easy to prepare a program that would control such manipulations and record the ensuing data (which could be scrutinized during the following session of the laboratory.)

There are, however, several immediately obvious problems to such an ambitious scheme. How to make connections of digital control-signal devices to the computer is not intuitively obvious, and the manuals of both Labview and Workbench lack a complete discussion. Even more importantly, the various peripheral devices needed for such automation come with many different specifications, and the physiologist/biologist is unlikely to be confident of which ones are most suitable. Because the costs of such devices range from fairly expensive to very expensive, it is not cost effective to learn which are suitable by buying many kinds and trying them all. It will require efforts by many people to determine whether such automated arrangements are suitable for student laboratories and to instruct biologists in setting them up.

I look forward to reading, in future issues of *Advances in Physiology Education*, many descriptions of the successful use of computers in teaching laboratories.

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COMPUTERS
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CONTENTS

A COMPUTER-BASED APPROACH TO REINFORCING COMMON PRINCIPLES IN BIOLOGY 81
Harold I. Modell

A COMPUTER-BASED APPROACH TO REINFORCING COMMON PRINCIPLES IN BIOLOGY

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Students often approach each course in a curriculum as a body of completely new information that has little in common with previous or future courses. In doing so, they fail to realize that our understanding of biological phenomena is based on a set of basic principles that are applied in a variety of ways. For example, the rate of molecular movement in biological systems by diffusion is governed by the same factors regardless of whether that movement is in a plant or in an animal system. Our task as "teachers" of biology is to help students recognize the existence of these common principles so that they can develop a conceptual framework in which what they now perceive as new knowledge is, instead, viewed as an extension or application of prior knowledge. Many colleagues would argue that they do, indeed, reinforce the notion of common principles by referencing prior applications when presenting new topic material. For example, when a pulmonary physiologist discusses gas exchange, he may mention at some point in the presentation that the equations governing alveolar gas exchange are based on the same principle of conservation of mass as the "Fick" equation for cardiac output or renal clearance equations. This reminder is often one sentence in a stream of information that contains unfamiliar symbols and certainly not the same symbols that were used when conservation of mass was presented previously. It may precede or follow presentation of the new application of the principle. In either case, the student must associate the system spe-

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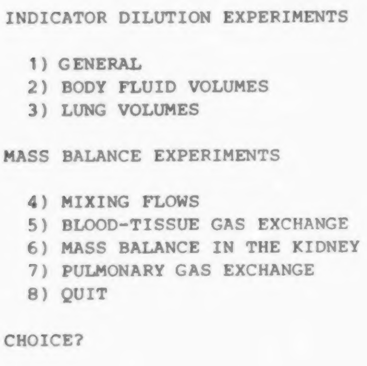
cific equation name (eg, Fick) with the principle before the similarity between applications can be made. As a result, the student often treats the new application as completely new information with a mental note to look back to find out what the Fick equation is all about. The student has again failed to apply prior knowledge to a new situation.

One approach to this problem may be to "precondition" students by exposing them to common principles in the context of the course material prior to the actual presentation of the course material. The purpose of this exposure would be two-fold; first, to expose students to the underlying principle, and, second, to make them aware that these principles are applied in a variety of ways in different aspects of the course material. Taking this approach, we have begun to develop a series of computer exercises designed for use in an independent study setting focusing on common themes in mammalian physiology. The purpose of this article is to describe the underlying philosophy and the key elements of the program developed to make students aware of the variety of ways in which conservation of mass is applied to physiological systems.



```
INDICATOR DILUTION EXPERIMENTS

   1) GENERAL
   2) BODY FLUID VOLUMES
   3) LUNG VOLUMES

MASS BALANCE EXPERIMENTS

   4) MIXING FLOWS
   5) BLOOD-TISSUE GAS EXCHANGE
   6) MASS BALANCE IN THE KIDNEY
   7) PULMONARY GAS EXCHANGE
   8) QUIT

CHOICE?
```

FIGURE 1. Main menu from conservation of mass program. The menu follows several text screens defining conservation of mass and emphasizing its importance in physiology.

TUTORIAL, DRILL AND PRACTICE, OR SIMULATION?

The overall goal of the program was to acquaint students with the principle of conservation of mass and demonstrate to them that even though specific applications of the principle may appear different, the underlying concept is still the same. To do this effectively, the student, of course, must be an active participant in the exercise and must be able to control the flow and extent of the experience. The first design question then became, "Can these goals be best met by using a tutorial, drill and practice, or simulation format?"

A traditional tutorial format in which information is presented and its acquisition tested is best suited for a progression of new information. However, the goal of this exercise was to promote the impression that the content underlying each aspect of the exercise was the same. Thus, although components of the program could certainly contain tutorial aspects, the overall thrust of the program should not be that of a tutorial.

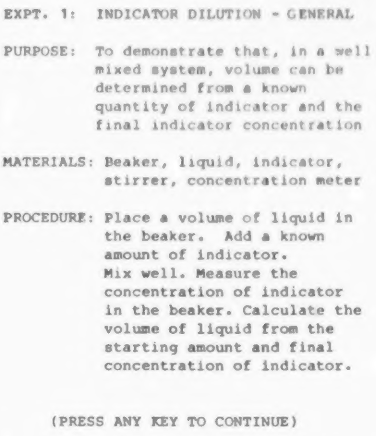
If the goal of the program was to help students become adept at applying the principle to physiological situations, the program should certainly provide repeated opportunities to work problems. In that sense, it should contain some aspects of drill and practice. Only, in this case, the student should play a role in defining the problem, and she should be able to control the total number of problems to be attempted.

The program should also contain some aspects of a simulation, for if applications of the principle are to be illustrated within the context of an experimental science, the student should participate in designing and conducting experiments.

The format of the program, then, contains aspects of all three approaches. The overall context of the exercises is that of a series of simulated experiments, all requiring some aspect of a conservation of mass analysis for determining the value of the parameter being sought. In defining the specific experiment, the student provides descriptive data about the subject or conditions of the experiment. From this description, the program calculates values for the physiological parameters within the system being tested. Thus, the simulated experiment leads to a drill and practice problem. Each drill and practice problem contains appropriate feedback for reinforcing the how conservation of mass is applied to the problem, should that be necessary.

PROGRAM OVERVIEW

The program begins with several text screens defining conservation of mass and emphasizing the range of applications to which this principle can be applied. This introduction ends by alerting the student to the overall goal of the program. The main menu, shown in Figure 1, shows the organization of the exercises. Two general aspects of conservation of mass are illustrated. The first is use of an indicator to determine an unknown volume. Three experiments are included. The goal of the first experiment is to demonstrate the use of the indicator dilution technique using a simple experimental design. The other experiments in this series illustrate appli-



```
EXPT. 1:   INDICATOR DILUTION - GENERAL

PURPOSE:   To demonstrate that, in a well
           mixed system, volume can be
           determined from a known
           quantity of indicator and the
           final indicator concentration

MATERIALS: Beaker, liquid, indicator,
           stirrer, concentration meter

PROCEDURE: Place a volume of liquid in
           the beaker.  Add a known
           amount of indicator.
           Mix well. Measure the
           concentration of indicator
           in the beaker. Calculate the
           volume of liquid from the
           starting amount and final
           concentration of indicator.


        (PRESS ANY KEY TO CONTINUE)
```

FIGURE 2. Screen introducing Experiment 1 focusing on the application of conservation of mass to indicator dilution techniques.

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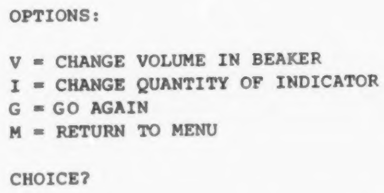
cations of this technique in physiological systems. The program flow then leads to application of mass balance relationships under various steady-state conditions. In this series of experiments, mass balance relationships are applied in a variety of ways using examples from cardiovascular, respiratory, and renal physiology.

INDICATOR DILUTION EXPERIMENTS

In this series of experiments, the student begins by confirming for himself that he can determine a unknown volume by adding a known amount of indicator to that volume, and, after the indicator is evenly distributed within the volume, measuring the final concentration (Figure 2). In a laboratory setting, the student would take a beaker containing a known amount of water, add a known amount of indicator, mix the system, measure the final indicator concentration, and calculate the original volume put into the beaker. The program provides a simulation of this experiment and shows the student the calculations involved (Figure 3). The student can either repeat the same experiment, change the volume in the beaker, change the quantity of indicator, or stop the exercise (Figure 4). When the student elects to return to the main menu, he is presented with one additional experiment in which an unknown volume has been put into the beaker. The student must then apply the calculation that has, so far, only been presented to him. If the student supplied answer in incorrect, the rationale underlying the calculation is reviewed, and the program suggests further examination of the principle with this set-up.

Having focused on the basic principle of indicator dilution, the next step is to deal with indicators that have specific volumes of distribution. Body fluid volumes serves as the context for this exercise. The student may measure plasma volume, extracellular fluid volume, or total body water using an indicator with the appropriate volume of distribution. The student defines the subject by providing the subject's weight. The program calculates values for various fluid volumes using standard relationships between body weight and individual fluid volumes, but it does not reveal these values to the student. The student then defines the volume of interest that will be measured and the amount of indicator added (Figure 5). The experiment is conducted, and the student is presented with the final concentration of indicator in the plasma. The student must then calculate the volume of interest (Figure 6). If the calculated answer is correct, the correct answer is confirmed, and the student is allowed to continue. If the answer supplied is incorrect, tutorial assistance is provided. The student may then elect to repeat the experiment using a different subject, a different volume of interest, or a different quantity of indicator. In this format, the student may generate a large number of problems dealing with the same relationships. To extend this range, the program includes a small amount of noise in the calculated volumes to account for biological variation. Hence, repeating the experiment with two subjects of the same weight does not necessarily yield the same values for the various volumes.

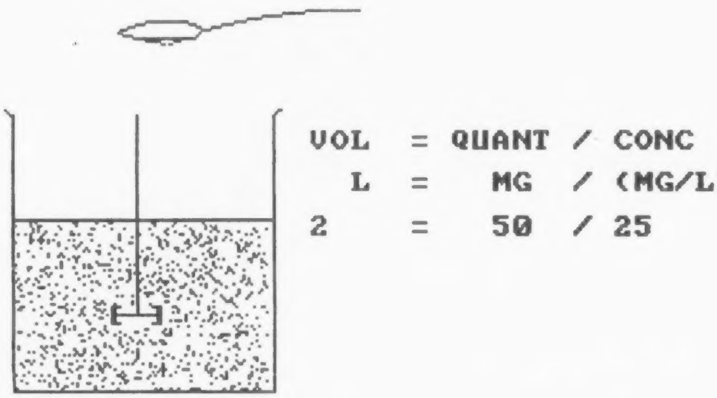


```
OPTIONS:

V = CHANGE VOLUME IN BEAKER
I = CHANGE QUANTITY OF INDICATOR
G = GO AGAIN
M = RETURN TO MENU

CHOICE?
```

FIGURE 4. Options menu for Experiment 1. This screen follows the one shown in Figure 3. The student can choose to change experiment variables, repeat the experiment, or return to the main menu.



```
VOL  =  QUANT  /  CONC
  L  =     MG  /  (MG/L)
2    =     50  /  25
```

FIGURE 3. Final screen showing general indicator dilution experiment. Earlier screens show the indicator being added to the beaker and the solution being stirred until the indicator is well mixed within the system.

The next exercise provides another example of an application of indicator dilution techniques. In this case, the volume is the lung volume at end-expiration, and the indicator is a tracer gas. The student again provides data describing the subject from which the program calculates the "unknown" value of the volume of interest. The experiment is a rebreathing experiment, and the student must also supply the volume of the rebreathing bag and the amount of the tracer gas to be used. In this exercise, the pictorial representation looks very different from that in the previous exercise (Figure 7). Although the problem "looks" different, the principle applied is the same.

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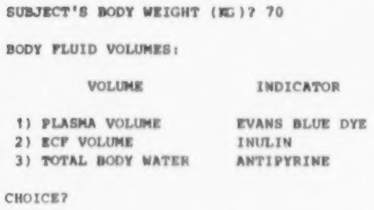
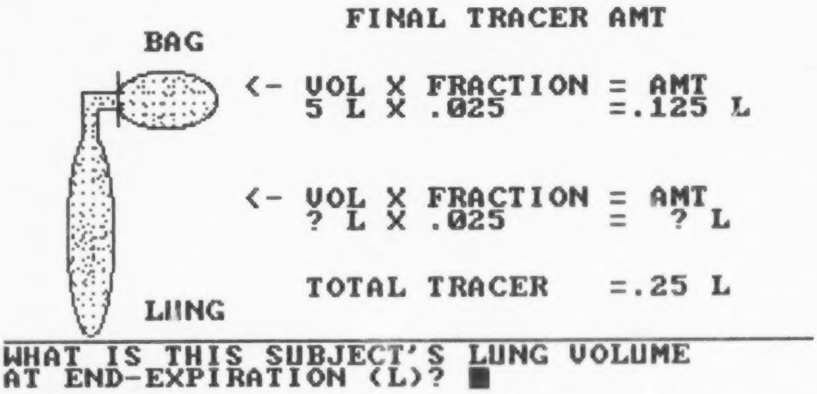


```
SUBJECT'S BODY WEIGHT (KG)? 70

BODY FLUID VOLUMES:

        VOLUME               INDICATOR

 1) PLASMA VOLUME          EVANS BLUE DYE
 2) ECF VOLUME             INULIN
 3) TOTAL BODY WATER       ANTIPYRINE

CHOICE?
```

FIGURE 5. Input screen from Body Fluid Volumes experiment. After designating the subject's body weight, the student can choose to measure plasma volume, extracellular fluid volume, or total body water. After choosing the volume of interest, the student is prompted for the amount of indicator that will be used in the experiment.

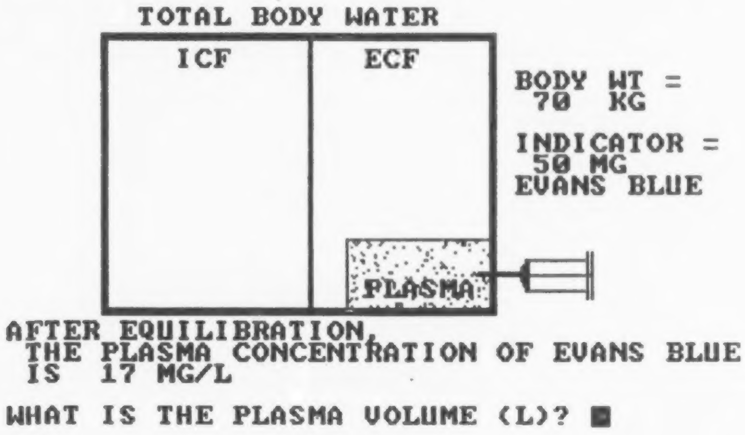


```
               FINAL TRACER AMT

<- VOL X FRACTION = AMT
   5 L X .025      =.125 L

<- VOL X FRACTION = AMT
   ? L X .025      =   ? L

   TOTAL TRACER    =.25 L

WHAT IS THIS SUBJECT'S LUNG VOLUME
AT END-EXPIRATION (L)? ■
```

FIGURE 7. Final pictorial screen from lung volume indicator dilution experiment. Previous screens show the initial conditions with all of the indicator in the rebreathing bag and an animated sequence depicting rebreathing to mix the indicator with lung gas.

MASS BALANCE EXPERIMENTS

The experiments in this portion of the program present the student with examples of situations from various areas of physiology that utilize mass balance calculations under steady-state conditions to determine values for desired parameters. In each case, the student defines specific aspects of the problem from which the correct value of the unknown parameter is calculated. Data are presented to the student, and he must calculate the correct value. The purpose of each experiment, the experimental situation, the student supplied variables that define the experiment, and the parameter value to be calculated for the experiments in this section of the program are presented in Table 1. The exercises illustrate applications of mass balance in cardiovascular, renal, and respiratory physiology. In each case, the pictorial representation of the experiment includes an animation to illustrate schematically the movement of mass within the system. These representations are designed to appear very different from each other (Figure 8) to further emphasize the point that even though the viewpoint may be different, the underlying principle is the same. Tutorial help follows any incorrect answers supplied by the student (Figure 9).



```
BODY WT =
 70  KG

INDICATOR =
 50 MG
EVANS BLUE

AFTER EQUILIBRATION,
  THE PLASMA CONCENTRATION OF EVANS BLUE
  IS  17 MG/L

WHAT IS THE PLASMA VOLUME (L)? ■
```

FIGURE 6. Screen depicting the Body Fluid Volumes experiment. In this case, the student chose to measure plasma volume in a 70 Kg subject using 50 mg of Evans Blue dye. A previous screen showed the dye being injected into and distributing within the plasma volume. The student must now calculate the plasma volume for this subject. If the student had chosen to measure extracellular fluid or total body water volume, the pictorial would have shown the indicator distributing within the appropriate volume following injection into the plasma volume.

ERROR MESSAGES

Although tutorial help is provided when students respond with an incorrect value for the requested parameter following each experiment, error messages must also be provided when the student enters inconsistent or unphysiological values while defining the conditions of the experiment. These error messages are also designed to provide information related to the feasibility of running a successful experiment under the conditions described. For example, if the quantitiy of indicator chosen results in concentrations that are too low for measurement with common laboratory equipment, an error message is presented alerting the student to the problem.

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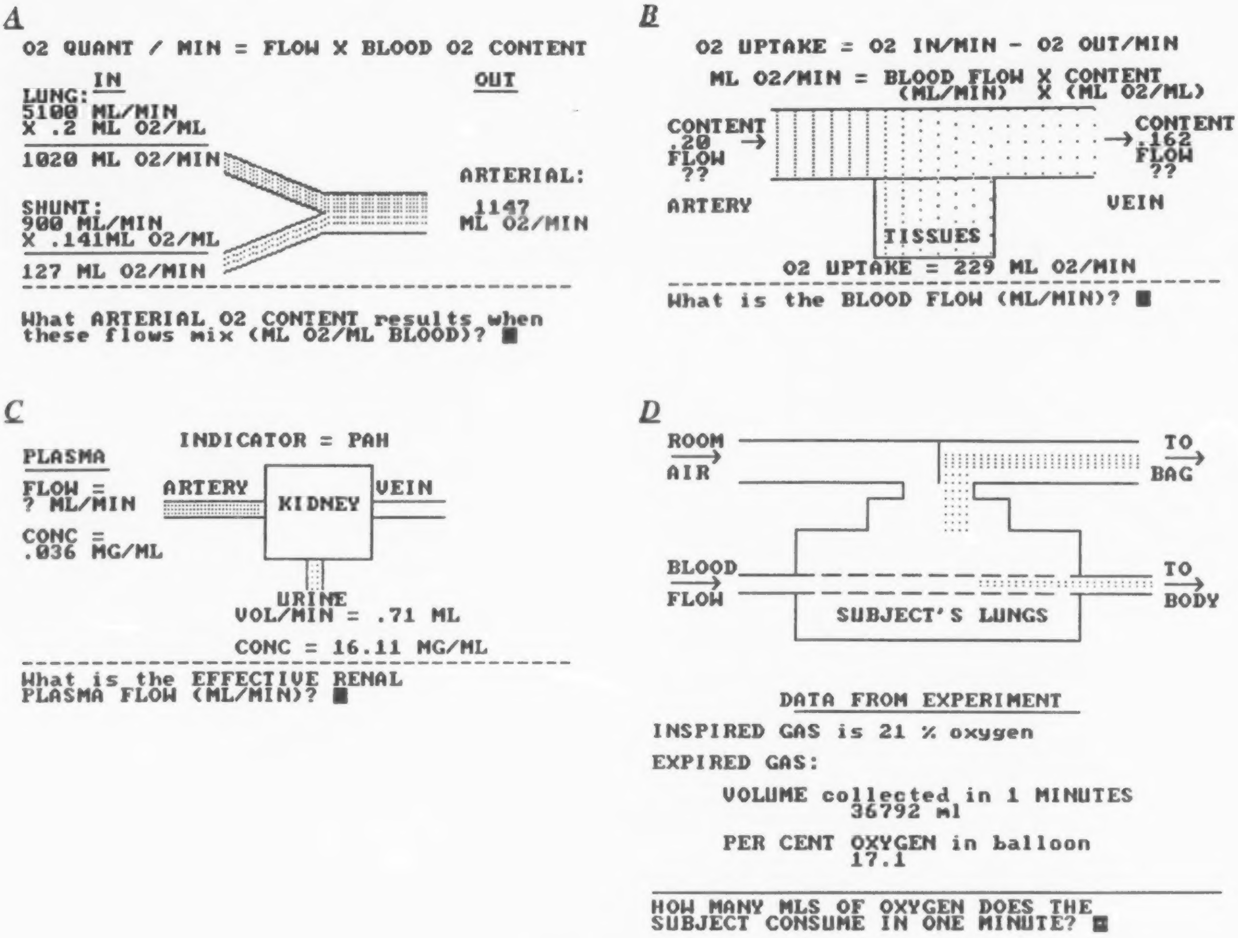
TABLE 1. Overview of mass balance experiments.

Exp't	Purpose	Situation	Assumptions	Student inputs	Value to calculate
4	To examine mass mixing from two flow sources	Patient with lung disease in which part of the total flow (cardiac output) bypasses the gas exchange areas of the lung (shunt).	Hemoglobin concentration = 15 gm/100 ml blood; Oxygen consumption = 300 ml/min	Patient's body weight; Per cent of flow that is shunt	Arterial oxygen content
5	To determine the cardiac output (total blood flow) in a normal 30 year old individual	The subject's oxygen consumption has been determined by applying mass balance principles to gas exchange in the lung. Mixed venous (pulmonary artery) blood has been sampled, and its oxygen content (ml O_2/ml blood) has been determined.	Hemoglobin concentration = 15 gm/100 ml blood; Arterial O_2 content = 0.20 ml O_2/ml blood	Patient's body weight	Blood flow
6	To apply the principle of conservation of mass with selective indicators to the kidney to measure effective renal plasma flow and glomerular filtration rate in a 30 year old subject.	The appropriate indicator is administered to a subject with functioning kidneys. A blood sample is obtained to determine the concentration of indicator in the plasma, and urine is collected over a period of time to determine how much indicator has been "cleared" by the kidney.	1) Any PAH entering the kidney is completely excreted in the urine. 2) Inulin is neither secreted nor reabsorbed by the kidney. Hence, any inulin reaching the nephron is removed from the plasma by filtration.	Subject's body weight; Indicator to use (PAH or Inulin); Quantitiy (mg) of indicator to administer	Effective renal plasma flow (PAH); Glomerular filtration rate (Inulin)
7	To illustrate mass balance applications in respiratory physiology	You are in a laboratory equipped with a treadmill, a weather balloon, a one-way breathing valve, a stopwatch, and an oxygen analyzer. Your task is to determine a subject's oxygen consumption during steady state, moderate exercise. While breathing room air through the one-way breathing valve, the subject runs on the treadmill. After a steady state is reached, expired gas is collected and analyzed.		Treadmill speed (Km/hr); Collection time for expired gas	Oxygen consumption



```
O2 QUANT / MIN = FLOW X BLOOD O2 CONTENT
     IN                                OUT
LUNG:
5100 ML/MIN
X .2 ML O2/ML
1020 ML O2/MIN
                                ARTERIAL:
SHUNT:                           1147
900 ML/MIN                      ML O2/MIN
X .141ML O2/ML
127 ML O2/MIN
----------------------------------------
What ARTERIAL O2 CONTENT results when
these flows mix (ML O2/ML BLOOD)? ■
```

```
O2 UPTAKE = O2 IN/MIN - O2 OUT/MIN
 ML O2/MIN = BLOOD FLOW X CONTENT
              (ML/MIN)  X (ML O2/ML)
CONTENT                          CONTENT
.20  →                         →.162
FLOW                             FLOW
??                                ??
ARTERY                           VEIN
                TISSUES
      O2 UPTAKE = 229 ML O2/MIN
-----------------------------------------
What is the BLOOD FLOW (ML/MIN)? ■
```

```
               INDICATOR = PAH
PLASMA
FLOW =        ARTERY            VEIN
? ML/MIN               KIDNEY
CONC =
.036 MG/ML
                       URINE
              VOL/MIN = .71 ML
              CONC = 16.11 MG/ML
----------------------------------------
What is the EFFECTIVE RENAL
PLASMA FLOW (ML/MIN)? ■
```

```
ROOM                                TO
AIR →                               BAG →

BLOOD                               TO
FLOW →                              BODY →
              SUBJECT'S LUNGS

          DATA FROM EXPERIMENT
INSPIRED GAS is 21 % oxygen
EXPIRED GAS:
    VOLUME collected in 1 MINUTES
             36792 ml
    PER CENT OXYGEN in balloon
             17.1
-----------------------------------------
HOW MANY MLS OF OXYGEN DOES THE
SUBJECT CONSUME IN ONE MINUTE? ■
```

FIGURE 8. Representative output screens from the four mass balance experiments summarized in Table 1. *Panel A:* Experiment 4, Mixing flows. *Panel B:* Experiment 5, Blood-tissue gas exchange. *Panel C:* Experiment 6, Mass balance in the kidney. *Panel D:* Experiment 7, Pulmonary gas exchange. The screens are designed to appear very different from each other to emphasize the point that even though the viewpoint may be different, the underlying principle is the same.

CALCULATOR FUNCTION

Most of the problems in this program require the student to carry out at least one calculation. To facilitate this, a simple calculator is incorporated into the the program. It can be accessed by one keystroke at any time that the program is seeking input. The student can use the calculator mode to do simple addition, subtraction, multiplication, and division problems and then return to the question from which the calculator was called.

CONCLUSION

The conservation of mass program represents one component of a series of exercises designed to redirect the way in which students approach biological information. The underlying premise of this and its companion programs is that if students are aware that our understanding of biological phenomena is based on a set of common principles or common themes, they will change their approach to "new" information. Instead of viewing this information as a new database, unrelated to their current database, they will view the new information as an extension of their current database. The goal of the software is not to teach specific applica-

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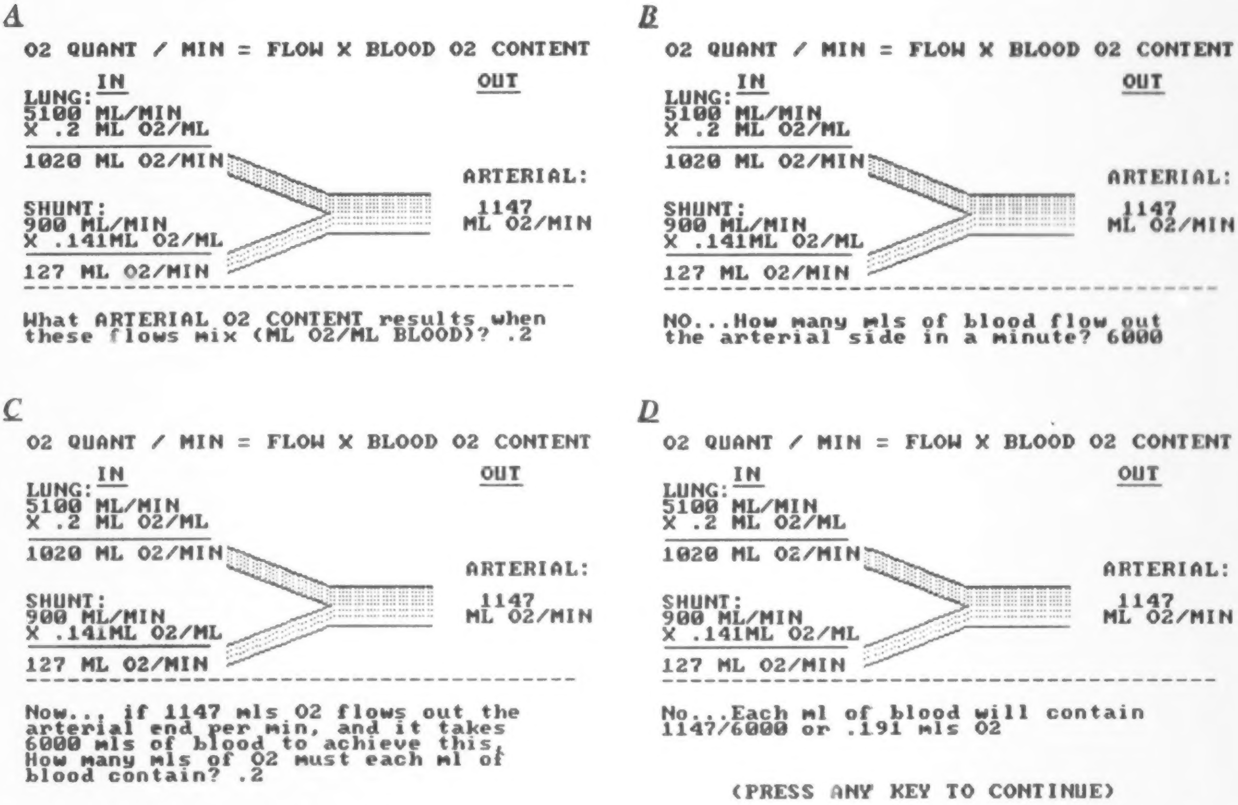

A

```
O2 QUANT / MIN = FLOW X BLOOD O2 CONTENT
      IN                               OUT
LUNG:
5100 ML/MIN
X .2 ML O2/ML
1020 ML O2/MIN
                                  ARTERIAL:
SHUNT:                             1147
900 ML/MIN                        ML O2/MIN
X .141ML O2/ML
127 ML O2/MIN
----------------------------------------
What ARTERIAL O2 CONTENT results when
these flows mix (ML O2/ML BLOOD)? .2
```

B

```
O2 QUANT / MIN = FLOW X BLOOD O2 CONTENT
      IN                               OUT
LUNG:
5100 ML/MIN
X .2 ML O2/ML
1020 ML O2/MIN
                                  ARTERIAL:
SHUNT:                             1147
900 ML/MIN                        ML O2/MIN
X .141ML O2/ML
127 ML O2/MIN
----------------------------------------
NO...How many mls of blood flow out
the arterial side in a minute? 6000
```

C

```
O2 QUANT / MIN = FLOW X BLOOD O2 CONTENT
      IN                               OUT
LUNG:
5100 ML/MIN
X .2 ML O2/ML
1020 ML O2/MIN
                                  ARTERIAL:
SHUNT:                             1147
900 ML/MIN                        ML O2/MIN
X .141ML O2/ML
127 ML O2/MIN
----------------------------------------
Now... if 1147 mls O2 flows out the
arterial end per min, and it takes
6000 mls of blood to achieve this,
How many mls of O2 must each ml of
blood contain? .2
```

D

```
O2 QUANT / MIN = FLOW X BLOOD O2 CONTENT
      IN                               OUT
LUNG:
5100 ML/MIN
X .2 ML O2/ML
1020 ML O2/MIN
                                  ARTERIAL:
SHUNT:                             1147
900 ML/MIN                        ML O2/MIN
X .141ML O2/ML
127 ML O2/MIN
----------------------------------------
No...Each ml of blood will contain
1147/6000 or .191 mls O2

          (PRESS ANY KEY TO CONTINUE)
```

FIGURE 9. Representative example of tutorial aid offered in response to an incorrect answer. This series is from Experiment 4 - Mixing Flows. *Panel A:* The student enters a value of .2 ml O_2/ml blood for the calculated arterial oxygen content. *Panel B:* In response to the wrong value, the program begins to lead the student through the calculation. *Panel C:* The tutorial process continues, and the student is again asked to calculate the arterial oxygen content. The entered response (.2) is again in error. *Panel D:* The correct answer is calculated and displayed for the student.

tions of the principle, but rather to heighten awareness of the range of applications of the principle. The target student population could be high school, undergraduate, or graduate level biology students. However, the choice of examples is oriented toward students studying mammalian physiology. The underlying premise remains to be tested, however, and will be the focus of a future study that will be conducted when the software series is completed.

PROGRAM AVAILABILITY

Additional topic areas that will be included in the Common Themes in Physiology series include osmotic pressure relationships, pressure-volume relationships, pressure-flow relationship, and feedback mechanisms. The conservation of mass and osmotic pressure relationships programs are currently available for MS-DOS systems from the National Resource for Computers in Life Science Education. A Macintosh version will be developed in the future. For further information, contact NRCLSE.

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

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Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 89

THE BULLETIN BOARD 91

SUMMARY OF LIQUID CRYSTAL DISPLAY PROJECTION PAD VENDORS 93

INDEX FOR VOLUME 7 94

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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JANUARY 7-9, 1991. Introduction to Interactive Video workshop, Bloomsburg, PA

Contact:

Dr. Harold Bailey
Institute for Interactive Technologies
1210 McCormick Center
Bloomsburg University
Bloomsburg, PA 17815
(717) 389-4506

JANUARY 18-20, 1991. Association of Biologists in Computing, Los Angeles, CA

Contact:

Bob Desharnais
Biology Department
California State University, Los Angeles
5151 State University Drive
Los Angeles, CA 90032-8201
(213) 343-2056

JANUARY 22-24, 1991. Sixth International Conference on Multimedia and CD-ROM, San Francisco, CA

Contact:

Mark LoGiurato
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Cahners Exposition Group
Cahners Plaza
999 Summer St.
P.O. Box 3833
Stamford, CT 06905
(203) 352-8224

FEBRUARY 5-8, 1991. 11th Annual Florida Educational Technology Conference. Tampa, FL

Contact:

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Conference Coordinator
Suite B1-54
Florida Education Center
325 West Gaines Street
Tallahassee, FL 32399
(904) 488-0980

FEBRUARY 20-22, 1991. Fifth Annual Conference - Learning Technology in the Health Care Sciences and Eighth Annual Conference - Interactive Instruction Delivery. Orlando, FL

Contact:

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Society for Applied Learning Technology
50 Culpeper Street
Warrenton, VA 22186

FEBRUARY 24-28, 1991. Seventh IEEE Conference on Artificial Intelligence Applications, Miami Beach, FL

Contact:

CAIA-91
The Computer Society of the IEEE
1730 Massachusetts Ave, NW
Washington, DC 20036-1903
(202) 371-1013

MARCH 4-8, 1991. Basic Skills Videodisc Design/Production Workshop, Lincoln, NE

Contact:

Nebraska Videodisc Group

1800 North 33rd Street
Lincoln, NE 68583
(402) 472-3611

APRIL 22-25, 1991. Communicating Disney Style Seminar, Lake Buena Vista, FL

Contact:

Walt Disney World Co.
Seminar Productions
P.O. Box 10,000
Lake Buena Vista, FL 32830-1000
(407) 363-6620

APRIL 6, 1991. The Social Creation of Knowledge: Multimedia and Information Technologies in the University, Cambridge, MA

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Cambridge, MA 02139

APRIL 19-20, 1991. Intellectual Property and Authorship, Cleveland, OH

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MAY 6-9, 1991. Nebraska Interactive Media Symposium, Lincoln, NE

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Nebraska Videodisc Group
1800 North 33rd Street
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(402) 472-3611

MAY 13-15, 1991. Introduction to Interactive Video Workshop, Bloomsburg, PA

Contact:

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Institute for Interactive Technologies
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Bloomsburg University
Bloomsburg, PA 17815
(717) 389-4506

JUNE 18-20, 1991. National Education Computing Conference, Phoenix, AZ

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NECC
(602) 965-7363

AUGUST 21-23, 1991. 13th Annual Conference on Interactive Videodisc in Education and Training and 7th Annual Conference on CD-ROM Applicatoins in Education and Training, Arlington, VA

Contact:

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Warrenton, VA 22186
(703) 347-0055

OCTOBER 16-19, 1991. EDUCOM '91, San Diego, CA

Contact:

EDUCOM '91 Program Committee
San Diego Supercomputer Center
University of California at San Diego
La Jolla, CA 92093-0505

NOVEMBER 10-14, 1991. 33rd International ADCIS Conference: Connections and collaborations – Technology and people for the 90's, St. Louis, MO

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NRCLSE RELEASES NEW SOFTWARE

NRCLSE announces the availability of the first two programs in our new series entitled "Common Themes in Physiology." The first program is a tutorial dealing with osmosis and osmotic pressure relationships (see CLSE, August, 1990). The second program is a problem set focused on applications of the principle of conservation of mass (see CLSE, November, 1990). Current versions of the programs are available only for IBM compatible equipment. Macintosh versions of the programs will be available late in 1991. The cost of each program is $30.00 (US). Permission to copy the programs is included in the purchase price.

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SUMMARY OF LIQUID CRYSTAL DISPLAY PROJECTION PAD VENDORS

Liquid crystal display (LCD) projection pads have improved considerably since their introduction several years ago. In 1987, Stull and Knoll surveyed this market and listed 5 distributers of LCD projection panels (see CLSE 4:76-77, 1987). The number of distributors has since more than doubled. Resolution has improved; units are available for a broader range of graphic output modes (CGA, EGA, VGA, Macintosh); and many units now offer "color" display. Last year CLSE presented our first list of LCD projection pad vendors to help CLSE readers identify sources of LCD projection pads that will meet their projection requirements. The following is an updated version of that list. If you are aware of other vendors that we have failed to list, please let us know about them. Send appropriate information to:

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Computer Accessories
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(612) 884-4051
(800) 828-6107

Toshiba America
1101A Lake Cook Rd.
Deerfield, IL 60015
(708) 945-1500

Visualon, Inc
3044 Payne Ave.
Cleveland, OH 44114
(800) 321-3860
(800) 362-3108 (Ohio)

SHARE YOUR EXPERIENCE

NRCLSE wants to know about *your* experiences with LCD projection pads. What brands and models have you used? How were they used? How well did they meet your needs? How have they changed you approach to teaching?

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COMPUTERS IN LIFE SCIENCE EDUCATION, VOLUME 7 INDEX

- Analog Connection WorkBench 10:73-80
- analog to digital conversion 10:73-80
- anatomy
  - colleagues 6:43, 7:53
  - software 2:9-10
  - videodiscs 5:37
- annual report, NRCLSE 1:5-6

- BICEP 5:34-35
- biology
  - colleagues 6:44-46
  - courseware 5:33-36
  - software 2:10-11, 5:34-36
  - videodiscs 5:37
- biotechnology videodisc 5:37
- botany
  - colleagues 6:46-47
  - software 2:11-12
  - videodiscs 5:37-38
- bulletin board 9:69-70, 12:91-92

- cell biology
  - colleagues 6:47
  - videodiscs 5:38
- clinical medicine
  - colleagues 7:51-53, 7:55, 8:63
  - software 2:12-13
  - videodiscs 5:38-39
- CLSE colleague directory 6:42-47, 7:49-55, 8:59-63
- colleagues
  - agronomy 6:43
  - anatomy 6:43
  - animal behavior 6:43-44
  - animal science 6:44
  - biochemistry 6:44
  - biology 6:44-46
  - biometrics 6:46
  - biophysics 6:46
  - biostatistics 6:46
  - botany 6:46-47
  - cell biology 6:47
  - chemistry 6:47
  - computer literacy 6:47
  - cytogenetics 6:47
  - cytology 6:47
  - dentistry 6:47
  - developmental biology 6:47, 7:49
  - ecology 7:49-50
  - education 7:50
  - electron microscopy 7:50
  - embryology 7:50-51
  - endocrinology 7:51
  - entomology 7:51
  - environmental science 7:51
  - epidemiology 7:51
  - evolution 7:51
  - family practice 7:51
  - fisheries 7:51
  - gastroenterology 7:51
  - genetics 7:51-52
  - hematology 7:52
  - histology 7:52-53
  - immunology 7:53
  - instructional design 7:53
  - internal medicine 7:53
  - laboratory medicine 7:53
  - limnology 7:53
  - livestock production 7:53
  - marine science 7:53
  - medical technology 7:53
  - microanatomy 7:53
  - microbiology 7:53-54
  - modeling 7:54
  - molecular biology 7:54
  - molecular genetics 7:54
  - natural history 7:54
  - neuroanatomy 7:54
  - neurobiology 7:54
  - neuroscience 7:54
  - nursing 7:54-55
  - nutrition 7:55
  - oral histology 7:55
  - oral pathology 7:55
  - ornithology 7:55
  - parasitology 7:55
  - pathology 7:55
  - pediatrics 7:55
  - pharmacology 8:60
  - physiology 8:60-63
  - plant physiology 8:63
  - population biology 8:63
  - psychiatry 8:63
  - quantitative biology 8:63
  - research techniques 8:63
  - serology 8:63
  - statistics 8:63
  - taxonomy 8:63
  - virology 8:63
  - zoology 8:63
- college freshmen 5:33-36
- common principles in biology 11:81-87
- computer as a teaching tool 1:1-8
- computer assisted instruction 4:25-28
- courseware, biology 5:33-36
- cytology
  - colleagues 6:47
  - software 2:13

- data acquisition systems 10:73-80
- drill and practice 11:82

- ecology
  - colleagues 7:49-50
  - software 2:13
- EDUCOM 1:2
- erratum 9:70
- evolution
  - colleagues 7:51
  - software 2:13-14
- Examiner 9:65-67
- examSYSTEM 9:65-67

- forestry software 2:14

- genetics
  - colleagues 7:51-52, 7:54
  - software 2:14, 3:18
- grade management 9:66
- grading systems 9:65-67

- health science videodiscs 5:39
- hematology
  - colleagues 7:52
  - videodiscs 5:39
- histology 4:25-28
  - colleagues 7:52-53

indicator dilution 11:83
integrated testing and grading systems 9:65-67
interactive video 1:2, 4:25-28

Jensh RP 4:25-28

Keeping Abreast of the Literature 3:17-18, 6:41-42, 9:67-68, 12:89-91

LabVIEW 10:73-80
Liquid Crystal Display Projection Pads 12:93
Lombardi GH 9:65-67

Macintosh 10:73-80
MacLab 10:73-80
mass balance experiments 11:84
medical histology 4:25-28
medicine software, clinical 2:12-13
microbiology
  colleagues 7:53-54
  software 3:18
MicroPac 9:65-67
MicroTim 9:65-67
miscellaneous software 4:29-30
Modell HI 1:1-8, 8:57-59, 11:81-87

neuroscience
  colleagues 7:54
  software 3:18-19
NRCLSE
  annual report 1:5-6
  feedback request 9:68
  questionnaire 1:7, 9:71
  software evaluation submission form 4:30-31
nursing
  colleagues 7:54-55
  software 3:19

osmosis 8:58-89

pathology
  colleagues 7:55
  videodiscs 5:40
Par System 9:65-67
pharmacology
  colleagues 8:60
  software 3:19
physiology
  colleagues 8:60-63
  software 3:19-22
  videodiscs 5:37
population dynamics software 3:22
projection pads 12:93

Ralph CL 5:33-36
reasoning skills 8:57-59

simulation 8:58-59, 11:82
software
  anatomy 2:9-10
  biochemistry 2:10
  biology 2:10-11, 8:57-59, 11:81-87
  botany 2:11-12
  clinical medicine 2:12-13
  cytology 2:13
  ecology 2:13
  evolution 2:13-14
  forestry 2:14
  genetics 2:14, 3:18
  microbiology 3:18
  miscellaneous 4:29-30
  neuroscience 3:18-19
  nursing 3:19
  pharmacology 3:19
  physiology 3:19-22, 8:57-59, 11:81-87
  population dynamics 3:22
  substance abuse 4:29
  zoology 4:29
substance abuse software 4:29
Swanson HD 10:73-80

teaching laboratories 10:79-80
technology in the classroom 1:1-2
test
  analysis 9:66
  delivery 9:66
  preparation 9:66
testing systems 9:65-65
tutorials 8:57-59

vendors
  LCD projection pads 12:93
  software 2:15-16, 3:22-23, 4:30, 9:67
  videodisc 5:37-40
videodiscs
  anatomy 5:37
  biology 5:37
  biotechnology 5:37
  botany 5:37-38
  cell biology 5:38-40
  health science 5:39
  hematology 5:39
  pathology 5:40
  pathophysiology 5:40
  physiology 5:37
  wildlife management 5:40
  zoology 5:40

wildlife management videodisc 5:40
Where are the Videodiscs? 5:37-40
Where's the Software? 2:9-16, 3:18-23, 4:29-30

zoology
  colleagues 8:63
  software 4:29
  videodiscs 5:40

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AIMS AND SCOPE

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INVITATION TO CONTRIBUTORS

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Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

NRCLSE ANNUAL REPORT FOR 1990 1
NRCLSE READER SURVEY 5
NRCLSE COLLEAGUE QUESTIONNAIRE 7

NRCLSE ANNUAL REPORT FOR 1990

The overall purpose of NRCLSE is to cultivate collaborative efforts among faculty with expertise in using computers in life science education. The broad goal of the Resource is fourfold:

1) to educate faculty in effective uses of computers in the curriculum;
2) to promote research aimed at evaluating new applications of the computer to life science education;
3) to promote development of a critical mass of high quality, versatile software, and
4) to serve in a consultant capacity for life science faculty currently active or interested in becoming active in this area.

This year's activities continued our efforts to serve the life science community. A statement of NRCLSE's financial status is presented in Table 1.

GENERAL OVERVIEW OF ACTIVITIES

Publication of *Computers in Life Science Education* continued to be NRCLSE's primary activity in 1990. However, during the past year, we continued to provide information to colleagues throughout the world concerning use of computers in life science curricula, participate in national meetings, conduct demonstrations at several institutions, and distribute our Simulations in Physiology software. We have also begun developing a new set of software focused on common themes in physiology. Two programs in the series were released for distribution in December. In an effort to better direct our software development projects in physiology, NRCLSE has begun a research project aimed at the medical student

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Table 1. NRCLSE Financial Report for year ending December, 1990.

Fund Balance, December 31, 1989		**$15,180**
Revenues		
Cash donations	1,771	
Subscriptions/Reprints	6,241	
Software/Manual sales	3,050	
Total Revenues	11,062	
Expenses		
CLSE production	4,388	
Postage/Shipping	2,292	
Operating expenses supplies, phone, etc.	2,664	
Travel	726	
Equipment	1,508	
Total Expenses	11,578	
Decrease in fund balance	(516)	
Fund balance, December 31, 1990		**$14,664**

population and designed to gain information related to the attitudes and needs of this population.

Computers in Life Science Education
Subscriptions to CLSE continue at the same level as in previous years, with about 45% of the subscriptions being held by libraries. The student population addressed by subscribers ranges from the high school level through the post-graduate level. About half of the subscribing institutions focus on undergraduate education, and about one third focus on medical education. The geographic distribution of subscribers continues to be broad. In addition to the U.S. and Canada, subscribers for 1990 included institutions in Australia, Denmark, France, Germany, Great Britain, Hungary, Israel, Japan, Norway, the Philippines, and Sweden.

Software distribution
In 1990, thirty sets of our simulations were distributed. Currently, 111 institutions representing thirteen countries on four continents have purchased one of the microcomputer versions of Simulations in Physiology - The Respiratory System.

Resource Information
During 1990, NRCLSE responded to 84 requests for information concerning use of the computer as an educational tool. As in previous years, the geographic origin of the requests continues to reflect our goal of providing worldwide service. Requests in 1990 were received from fourteen countries in addition to the United States.

Presentations/Consultation
Dr. Modell led a workshop entitled "The role of computer simulations in the student laboratory" held at the fall meeting of the American Physiological Society in Orlando, FL. He also was an invited speaker at the annual retreat of the Association of Chairs of Departments of Physiology held in Scottsdale, AZ.

NRCLSE also visited two medical schools in 1990 to demonstrate the use of the computer to foster active learning in the classroom and discuss uses of computers in the basic science curriculum,

New software initiative
NRCLSE began work on a new software package this year. The package will consist of a series of tutorials, simulations, and problem sets focused on common themes in physiology. The MS-DOS version of two programs in the series were released in December. The first is a tutorial dealing with osmotic pressure relationships. The approach taken in this tutorial differs somewhat from the "traditional" CAI question and answer tutorial. The philosophy on which this program is based was described in the August, 1989 issue of CLSE. The second program, focusing on the principle of conservation of mass, is a problem set aimed at helping students realize that this principle is applied in many different ways and in many areas of physiology. This program was described in the November, 1989 issue of CLSE. The new programs have been priced at $30.00 each, and the NRCLSE policy of granting permission to purchasers to make as many copies of the program as is necessary to service their student populations will apply to the new programs.

Topics for other programs projected for development in this series include pressure-flow relationships, pressure-volume relationships, and homeostasis (e.g., control systems).

Research initiative
In January, 1990, NRCLSE began a project designed to learn more about how medical students view physiology and to determine how well students draw on previous experience to solve problems relevant to physiological systems. As the first step in this process, medical students at 5 institutions were asked to complete a survey on the first meeting of their physiology class. The survey contained a number of items directed toward the students' expectations for the class. It also contained a problem dealing with one basic principle relevant to physiol-

ogy (e.g., conservation of mass). Results of the initial survey will be presented at the annual meeting of the Federation of American Societies for Experimental Biology (FASEB) to be held in Atlanta, GA in April.

Special thanks

NRCLSE extends a very special "Thank you" to the following people, organizations, and institutions for their support in 1990.

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Bethesda, MD 20814

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University of Washington
Seattle, WA 98195

NEW FROM NRCLSE

COMMON THEMES IN PHYSIOLOGY

Harold I. Modell, Ph.D.

Program 1
Osmotic Pressure

Tutorial format using simulated experiments

MENU
1) Determinants of osmotic pressure
2) Cell reactions to osmotic environments
3) Fluid movement at the capillary
4) Quit

Program 2
Conservation of Mass

Simulations/Problems applying conservation of mass principles to physiological situations

MENU
INDICATOR DILUTION EXPERIMENTS
1) GENERAL
2) BODY FLUID VOLUMES
3) LUNG VOLUMES
MASS BALANCE EXPERIMENTS
4) MIXING FLOWS
5) BLOOD-TISSUE GAS EXCHANGE
6) MASS BALANCE IN THE KIDNEY
7) PULMONARY GAS EXCHANGE
8) QUIT

- **Available for MS-DOS compatible equipment (Macintosh version available late 1991)**
- **Purchase includes permission to make enough copies to supply appropriate student populations**
- **Cost: $30.00 per program**
- **Order from NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187 (Tel. 206-522-6045)**

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SIMULATIONS IN PHYSIOLOGY

– The Respiratory System –

Harold I. Modell, Ph.D.
School of Medicine, University of Washington, Seattle, Washington 98195

- **Series of 12 Simulations in Respiratory Physiology**
- **117 Page Laboratory Manual**
- **Designed for use in student laboratory and group discussion environments**
- ***Pictorial* outputs designed to provide conceptual aid, show where variables values are measured, or illustrate the model and how it is solved**
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- **Purchase includes permission to make enough copies to supply appropriate student populations**

ORDERING INFORMATION

Computer Programs*
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Documentation
One copy of student laboratory manual $100

*IBM-PC version uses CGA graphics

Student Laboratory Manuals
Quantities of 1-25 . . . . $10 each
Additional copies . . . . $8.50 each

Address orders to:
NRCLSE
P.O. Box 51187
Seattle, WA 98115

Be sure to indicate which version you need!

PROGRAM OVERVIEW

Title	Material
MECHANICS	
Static Relationships	Elastic properties of the lung, chest wall, and total respiratory system
Dynamic Relationships I	Effects of lung compliance and airway resistance on tidal volume development
Work of Breathing	Oxygen cost of elastic, resistive, and total work during inspiration
Dynamic Relationships II	Respiratory dynamics of the total respiratory system
GENERAL GAS EXCHANGE	
Alveolar Gas Exchange	Gas exchange between atmosphere and alveolar reservoir
O_2 and CO_2 Dissociation Curves	Interrelationships between the O_2 and CO_2 dissociation curves
Exchange from Atmosphere to Tissues	Influence of alveolar ventilation, cardiac output, and anatomic shunt flow on arterial blood composition and gas exchange at the tissues
Chemoregulation of Respiration	Influence of chemoreceptor sensitivity and respiratory mechanics on O_2 and CO_2 response curves
V_A/Q RELATIONSHIPS	
Gas Exchange in a Single Alveolus	Effects of ventilation-perfusion ratio and inspired gas composition on exchange in a single exchange unit
The Non-Uniform Lung	Gas exchange from atmosphere to tissues with V_A/Q mismatching in the lung
Overall Gas Exchange	Gas exchange from atmosphere to tissues with V_A/Q mismatching and a true shunt
ACID-BASE BALANCE	
Acid-Base Balance: Fundamental Relationships	Acid-base balance from a Base Excess viewpoint

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NRCLSE READER SURVEY

CLSE is entering its eighth year of publication. Our goal is serve as a means of communication and as a resource for life science educators interested in using the computer as an educational tool. The complexion of the newsletter has changed somewhat over the years. In order to best serve our readership, we need to know what your current needs are, what you project your future needs to be, and what features of the newsletter have proven useful to you. Please take a few moments to complete this survey and return it to **Reader Survey, NRLCSE, P.O. Box 51187, Seattle, WA 98115-1187.**

Harold I. Modell, *Editor*

Part 1 – Directions: Please respond to the following statements according to the code

SD = Strongly Disagree
D = Disagree
N = Neutral
A = Agree
SA = Strongly Agree

1. I remember seeing most issues of CLSE during 1990.	SD	D	N	A	SA
2. I have read more than 3 articles that appeared in CLSE in 1990.	SD	D	N	A	SA
3. I have looked up a reference that appeared in *Keeping Abreast of the Literature* in 1990.	SD	D	N	A	SA
4. I have used *Where's the Software?* to locate software that I considered for use in my classes.	SD	D	N	A	SA
5. I have contacted or tried to contact at least one person listed in the *NRCLSE Colleague Directory* that appeared in CLSE in 1990.	SD	D	N	A	SA
6. I have used the*Where Are the Videodiscs?* feature to locate videodisc material for use in my classes.	SD	D	N	A	SA
7. I am planning to use the listing of LCD projection pad vendors that appeared in the December issue to locate an appropriate projection device to use in my classes.	SD	D	N	A	SA
8. During 1990, I have told at least one colleague about information that appeared in CLSE.	SD	D	N	A	SA

Part 2 – Directions: Please use the space provided to answer the following questions.

1. What article or feature that appeared in CLSE in 1990 did you find *most* valuable?

2. What article or feature that appeared in CLSE in 1990 did you find *least* relevant to you teaching efforts?

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3. What additional regular features would you like to see added to CLSE?

4. What specific topics would you like to see addressed by CLSE articles?

Part 3 – Directions: Please help us identify software that makes a difference. For each program that you or your students have found helpful in your curriculum, please supply the following information.

Name of the software:

Source of the software:

Approximate price of the software:

Type of program (Tutorial, Simulation, Drill & Practice, Combination):

Equipment needed to run the program:

Student population that use this software in your environment:

Content area covered by this software:

How do you use this software in your environment (Independent study, classroom instruction, student laboratory)?

Would you be willing to discuss your experience with this program with colleagues?

What do you like *best* about this software?

What do you like *least* about this software?

NATIONAL RESOURCE FOR COMPUTERS IN LIFE SCIENCE EDUCATION QUESTIONNAIRE

It is time once again to update our CLSE colleague directory. Please help ensure that we provide accurate information. Take a few minutes to complete the questionnaire below and return it to the following address:

Harold Modell, Ph.D.
NRCLSE
P.O. Box 51187
Seattle, Washington 98115

Name: ____________________

Address: ____________________

____________________ State ________ Zip ____

Phone: ____________________ BITNET: ____________________

What content areas do you teach? ____________________

What student population(s) do you serve? (Please check appropriate categories)

____ Undergraduate ____ Graduate ____ Nursing ____ Medical

____ Allied Health ____ Dental ____ Veterinary

____ Other (please specify) ____________________

Are you currently using the computer as an educational tool? ___ Yes ___ No

If yes:

How many years have you used the computer in this way? ________

What kind of equipment are you using?

Have you written any software for use in your teaching efforts? ___ Yes ___ No

What commercially available software have you found useful?

Would you be willing to help critique software for peers? ___ Yes ___ No

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SCIENCE
EDUCATION

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CONTENTS

CONSTRUCTING A SCIENCE CENTER IN THE AGE OF HYPERMEDIA 9
Michael A. Kolitsky

WHERE ARE THE VIDEODISCS? – PART 1 13

CONSTRUCTING A SCIENCE CENTER IN THE AGE OF HYPERMEDIA

Michael A. Kolitsky

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Science instruction and, for that matter, teaching in general has been undergoing a renaissance as the new pedagogical options offered by Hypermedia technology begin to take hold. Hypermedia or Multimedia may be described in general as the synthesis of the power and versatility of the computer with the rich visual imagery and large storage capacity of optical information systems such as the videodisc and CD-ROM. Still frame and motion video, digitized voice and everyday sounds, graphics and graphics overlay for animation and simulation, computer modeling, 3-D graphics, 24 bit desktop video boards displaying 16.7 million colors, desktop video boards for professional videographics production, 24 bit video frame capture, and low cost animation and graphics rendering programs all comprise a constellation of Hypermedia tools now available for individual instructors to employ in the production of their own courseware. Hypermedia may be employed in the lecture hall with large screen presentation systems (i.e., electronic blackboards) or may be designed for use at interactive video learning stations for a more individualized learning experience. In whatever way Hypermedia is utilized for instructional purposes, the common denominator is that it is a new way to teach or learn. Just as the structure that supported teach-

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ing changed when someone first formalized the use of chalk on slate board, the structure now must change and be reflected in our new building design to support the effective employment of Hypermedia in our classroom and labs. This report will document the design features incorporated into the construction of our new science center that specifically support the implementation of Hypermedia teaching technology.

Members of the science division at California Lutheran University began to plan for a new science center during the 1985-86 academic year. The science center project at California Lutheran University was completed during the summer of 1987 with classes first offered in September of that year. The building is a two-story structure, 30,000 square feet in area, and houses the Departments of Biology, Chemistry, and Geology. The new building was designed for a future phase construction of a wing to house the Departments of Computer Science, Math, and Physics. The latter departments now use the old science building which underwent renovation during the construction of the new science center.

The planning and design phase for the new science center served not only to produce an architectural blueprint for building construction, but also resulted in a more clearly defined vision of future departmental growth and programmatic possibilities. Two major foundation grant proposals grew directly from the planning sessions. The first proposal was presented to the Weingardt Foundation to support the purchase of instrumentation that would allow undergraduates to learn recombinant DNA methodology. The Weingardt Foundation supported this request with a $150,000 grant for biotechnology equipment. In the two years following the grant award, a new faculty member skilled in recombinant DNA studies has been added to the Biology Department staff, a new Biochemistry and Molecular Biology major has been approved, and the first two seniors in this major will be graduated in May, 1991. The second proposal requested funds from the Fletcher Jones foundation for a Hypermedia Laboratory which they supported with an award of $110,000. The Hypermedia Lab equipment configuration will be described in more detail later in this report.

Knowledge of the potential ways that Hypermedia could be utilized for classroom or laboratory instruction influenced building design in three ways. First, an electronic lecture hall specifically designed to support lecturing with a Hypermedia presentation system (i.e., an electronic blackboard) was included in the building plans. Next, a Hypermedia Laboratory consisting of thirteen interactive videodisc learning stations was included for more individualized or personalized instruction. Finally, space was set aside for an Optical Data Design Center that would provide the technological, pedagogical, and aesthetic support for our faculty to design and produce their own videodiscs.

ELECTRONIC LECTURE HALL

The design of our electronic lecture hall was based on prior experience gained with the use of our first electronic blackboard system which was configured in late 1984. This system consisted of an Apple //e computer, a Pioneer LD-V4000 videodisc player, a VAI video switching device (Optical Data Corporation, 30 Technology Drive, P.O. Box 4919, Warren, NJ 07060), a Sony 1030Q videoprojector and the BioSci Videodisc (Videodiscovery, 1515 Dexter Ave. N., Suite 400, Seattle, WA 98109). The video switching device responded to BASIC software commands from the Apple //e by modifying its output so that only the computer graphics from the Apple //e or the video image from the videodisc player would be displayed by the videoprojector. The videoprojection monitor was able to produce a video image about 140 square feet in area on a flat screen. In this way, a single screen output was achieved with a large enough viewing area so that this first electronic blackboard was able to be utilized for classroom instruction in a 250 seat lecture hall. Thirteen biology courses including Anatomy and Physiology, Embryology, Cell Biology, and Biochemistry were taught using the electronic blackboard as the sole source of visual imagery. The electronic blackboard effectively replaced the need for a chalkboard, overhead projector, or slide projector and won high praise from students in course evaluations.

With this experience in mind, the main lecture hall of the new science center was designed to seat 95 students and accommodate the large screen projection of normal video (NTSC) and RGB video. By the time the science center as completed, we had also switched from the Apple //e to the Macintosh platform which meant that the videoprojector for the lecture hall had to be a multiscan monitor in order to match the higher scan rate of the Macintosh computer. A Sony 1030Q multiscan videoprojection monitor was selected and hung from a ceiling mount in the lecture hall. The structural supports for a videoprojection monitor were also included in every classroom and laboratory in the science center where it was thought that videoprojection might be needed in the future. Conduits run from the ceiling mounted videoprojection monitor to a control panel located on the left front wall of the lecture hall and to the demonstration table at the front center of the lecture hall. A Sony control box (Model #VPR-722) for color balance, picture brightness and on/off switching was placed in the front demonstration table, and the control cables connect to the videoprojection monitor.

The remote control box allows for the projection of three video sources. Two separate NTSC video inputs are possible as well as one RGB input from a Macintosh, IBM, or IBM compatible computer. Only one video source may be displayed at a time, and hard switches on the control

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box allow for the manual choice of either NTSC input or RGB input. All three inputs have been utilized in lectures in the following way. One NTSC video input was from a live video camera mounted on a copy stand, and the other NTSC video signal arose from an Hitachi still video recorder (Mideo Systems Inc., P.O. Box 1517, Huntington Beach, CA 92647) that can capture and store fifty video images on one tiny floppy disk. The still video recorder/player is a linear display device and must be operated with its own manual hand-held controller, but it is a useful third source of video information for class presentations. For example, just the right microscope slide area can be found prior to the class at the instructor's convenience and captured on the floppy disk for immediate display when desired during a lecture by simply pressing the proper display button on the controller box.

The live video camera mounted on a portable copy stand provides a convenient way to display text book pictures, microscope slide films, and solid objects such as bones, shells, or fossils. The instructor may also utilize the live video stand as a way to display spontaneous writing and drawing on paper.

The RGB input line has played the most significant role this far because it can display the output of the desktop video Hypermedia presentation system. This type of electronic blackboard utilizes a Macintosh II series computer, a Colorspace IIi desktop video board (Mass Micro Systems, 550 Del Rey Ave., Sunnyvale, CA 95086), and a Pioneer LD-V4200 videodisc player. The Colorspace IIi board accepts an NTSC video signal from the videodisc player and "gen locks" it (combines it) with the RGB signal produced by the Macintosh to produce a graphics overlay option. In the "graphics only" mode, the RGB Macintosh graphics fills the entire screen. In the "graphics over video" mode, a single color of the 256 colors available is chosen to be the transparent color and the video is now displayed wherever the transparent color is located on the screen. I normally select the "whitest" of the shades of white as the transparent color so that, in the "graphic over video" mode, the white color of a new Hypercard card or SuperCard frame is the transparent color. The Hypermedia presentation system offers instructors the option of projecting large screen video displays from any of five possible sources. There are three types of RGB display that comprise a "video only," "graphics only," and "graphics over video" mode and two types of NTSC video that arise from the live video copy stand or the still video recorder/player as previously described.

An electronic lecture hall designed for Hypermedia video projection offers many pedagogical options not possible with traditional audio-visual equipment. Computer animation, experimental simulations and modeling, still frame and motion video, and professional videographic techniques may now be employed in the lecture setting. These options encourage the viewpoint that teachers of the future will probably not "write" lectures as much as they will "produce" them. but as potentially exciting as all this is, there remains an important caveat that must be recognized and accommodated for in the structural design of an electronic lecture hall in order for the videoprojection system to operate effectively. The critical problem rests with room lighting and the lumens able to be projected by the "lower cost" multiscan videoprojection monitors. An entry level multiscan videoprojector may cost from $7,000-10,000 and yet suffer from the problem that back lighting will wash out the video projected image making it impossible to see. The problem may be solved by designing rows of adjustable tungsten lights in the ceiling so that the screen area may be darkened and the student area lit well enough for note taking. In our lecture hall, there are also banks of fluorescent lights that may be turned off or on for room use when the electronic blackboard is not employed. The two front doors that permit entry to the lecture hall by students are also inset at angles so that light from the outside atrium area will not fall directly on the screen when persons enter the lecture hall after the electronic blackboard is in use and the room lighting has been adjusted. A traditional audio-visual projection booth is located in the rear of the room to provide for slide or movie projection needs, and its side walls serve as the barrier to prohibit stray light from door openings from falling on the video-projected image.

HYPERMEDIA LABORATORY

In 1985, the Department of Biological Sciences received a College Science Instrumentation Award from The National Science Foundation which provided funds to outfit five computer-mediated physiology laboratory workstations. In these stations, inexpensive light sensitive interfaces were constructed and connected to Apple //e computers in the game port so that, with appropriate BASIC software, the stations would act like oscilloscopes, densitometers, pH meters, or physiographs. These stations, when not being utilized in the physiology lab, also served as our first interactive videodisc learning stations with the addition of a second monitor for the videodisc player. Several programs were written in BASIC which enabled students to use the BioSci and Cell Biology videodiscs produced by Videodiscovery in an interactive manner to study mitosis and compare procaryotic/eucaryotic characteristics.

This experience provided us with the background knowledge to design a Hypermedia lab which was configured with hardware purchased with funds awarded by the Fletcher Jones Foundation. The Hypermedia Lab consists of thirteen interactive videodisc learning stations, configured as two screen systems. Each station was composed of a Macintosh II computer (2MB RAM, 8-bit video card)

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and RGB HiRes monitor (Apple Computer), an extended keyboard, a Pioneer LD-V4200 videodisc player, and a Sony Trinitron monitor (PVM-1390). One station was designed for desktop publishing by the incorporation of an Apple flatbed scanner and an Apple Laser-Writer NT printer. The printer was accessible to all the computer stations in the lab. PageMaker (Aldus Corporation, 411 First Ave. S., Seattle, WA 98104-2871) was included at the desktop publishing station, and extra RAM was installed to bring the total RAM memory to 5 MB. Another station was configured as a graphics and sound digitizing station. ComputerEyes (Digital Vision, Inc., 270 Bridge St., Dedham, MA 02026) was utilized for digitizing flat or solid objects so that the graphics were able to be stored and utilized for courseware development. MacRecorder (Farallon Computing, Inc., 2150 Kittridge St., Berkeley, CA 94704) was employed for the digital capture and manipulation of live voice-generated sounds and sounds originating from a CD-ROM drive which was also included at this station.

The Hypermedia Lab has been utilized as a faculty training center for Hypermedia courseware development and as a classroom/lab for student learning. In April, 1989, a two-year grant from the Consortium for the Advancement of Private Higher Education made available just under $80,000 to train faculty to use videodiscs and Hypercard for the development of Hypermedia courseware. The grant was aimed at faculty from all disciplines, and, in the first year, 28 faculty from 18 different disciplines were trained to generate their own Hypermedia courseware. Thus far, 15 faculty implemented their projects in the classroom or lab with six of these faculty coming from the natural sciences. The lab is heavily used by faculty and students from science and non-science disciplines, and it is not unusual to see a student, for example, from our embryology course utilizing a learning station and Hypermedia courseware for simulated microscopy sitting next to a drama student who is using Hypercard/videodisc courseware to analyze the dramatic structure of a play.

OPTICAL DATA DESIGN CENTER

The Optical Data Design Center was established to assist our faculty in the design and production of videodiscs and Hypermedia courseware. The first videodisc produced by the center as a "share disc" in that the Departments of Art, Biology, French, Geology, and History contributed visual imagery to the production of the videodisc. The videodisc was also considered to be a "data base" disc in that all visuals were from 35 mm photographic slides. An outside pre-mastering firm was employed to transfer these slides to a one-inch videotape master which was then sent to the videodisc production firm (Disctronics Manufacturing, Ind., 1120 Cosby Way, Anaheim, CA 92806).

The biology portion of the videodisc was the most complete in a pedagogical sense in that it contained all the microscope slide images normally viewed in a vertebrate embryology laboratory course. At this time, our embryology lab has been offered twice, and the Hypermedia learning stations were utilized in both semesters for simulated microscopy. an atlas of labeled digitized sections was also included on the videodisc. It has been observed that students finish the assigned labs quicker than when employing traditional microscope methods which has allowed us to include more experimental embryology in the course than was possible before. It is in the experimental embryology labs that we ensure that our students still receive experience utilizing microscopes.

The Optical Data Design Center has recently been configured with a cutting-edge videographics/videodisc recording station that will permit us to lower considerably the cost of premastering for videodisc production. The videographics station consists of a Macintosh IIfx computer containing a 160 MB hard drive and 8 MB of RAM memory. This computer serves as a video digitizer by the incorporation of a 24 bit color video digitizer produced by RasterOps (Model 364). The 364 board digitizes NTSC and S-video input at 30 frames/second and permits display of 16.7 million colors on the Apple Hi-Res monitor. Next to the computer is a professional video copy stand that employs a JVC video camera (Model BY-10U) with a zoom lens system capable of capturing images from 35 mm photographic slides, flat art work, or solid objects. The digitized images may be saved in PICT files for further work when imported into 24 bit graphics programs such as PixelPaint Professional or Adobe Photo Shop. Completed graphics may then be stored on a Panasonic optical drive (Model LF 5010) capable of storing 970 MB of information or transferred directly to the videodisc recording station. Animation sequences lasting up to 20 seconds and playing at 30 frames/second will require the storage of 600 frames with each 24 bit frame taking up almost 1 MB of RAM. One optical disk for the Panasonic optical drive will be utilized per animation sequence.

The videodisc recording station is composed of a Panasonic optical magnetic disc recorder (TQ 3031F) and a Sony Time Base corrector (MPU-F100). The videodisc recorder will accept an NTSC, RGB, or S-video signal and record it on a videodisc cartridge. In our system, the S-video signal from the JVC video camera can be sent directly to the videodisc recording station or the digitized video images, or pure graphics generated by the Macintosh IIfx can be sent to the recording stations after passing from the computer through a video encoder (RasterOps, 2500 Walsh Ave., Santa Clara, CA 95051) which produces an S-video or NTSC video signal. The cost of premastering has been reduced considerably with this system. For example, it costs about one dollar per 35

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mm photographic slide to have a commercial premastering firm transfer the slide image to one-inch videotape, but our costs for transferring the same slide to the videodisc on the recording station would be 10-20 cents, a 5-10 fold saving of funds. The videodisc cartridge produced by this system plays only on Panasonic players (Model TQ 3032F), but it is not intended to be the final product. The videodisc cartridge is accepted in place of one-inch videotape by the videodisc mastering firms such as Disctronics. Our goal in setting up the recording station is to eliminate the need for one-inch editing which drives up the cost of videodisc premastering. The quality of videodiscs premastered from one-inch videotape will usually be better than using the videodisc cartridge method, but the videodisc cartridge is better than using 3/4 inch videotape and provides a much more affordable route for videodisc production.

The Optical Data Design Center is working on several current videodisc projects. The first project is a second version of our embryology videodisc which will contain more mammalian embryology and also early human embryology. The second project entails producing a BioAnimations videodisc that will contain animated graphic sequences of commonly discussed concepts in biology to assist in lecture or for inclusion in Hypermedia courseware to be used at interactive videodisc learning stations. The third project is further in the future and is envisioned as an evolution/comparative anatomy video data base.

SUMMARY

The importance of videodiscs, CD-ROMs, microcomputers, and faculty generated courseware is steadily increasing. Faculty at many colleges, universities, and throughout D-12 schools are beginning to explore how best this technology should be used in the classroom and laboratory. Visual resources for videodisc and CD-ROM production are needed and, where round, are considered valuable commodities. The Optical Data Design Center at Cal Lutheran has as one of its goals to be a visual production center to assist faculty with their videodisc design needs.

Hypermedia courseware production first requires that equipment and a properly designed architecture to make the delivery of Hypermedia efficient. It is oftentimes difficult to find funding for large hardware purchases but the model that has worked for us centers on the idea that we needed to build a building for the present and the future and incorporated into it the structural realities for visions able to be funded by foundations. The role that Hypermedia is playing in the improvement of teaching and in the exploration of new ways to teach is as significant to science education as the recombinant DNA revolution has been to the growth and establishment of molecular biology as a discipline. Hypermedia may very well be the vehicle for fuelling a renaissance in teaching excellence and for redefining faculty scholarship to include teaching scholarship. For these reasons, it is paramount that our science centers be constructed or remodeled to reflect the future visions and opportunities afforded by our entry into the age of Hypermedia.

WHERE ARE THE VIDEODISCS? – PART 1

Applications of interactive video in life science education continues to grow. As the cost of the technology necessary to implement interactive video falls within the feasibility range of institutions and the interest in Hypermedia continues to grow, more educators are looking for sources of video images or interactive video courseware to use in their teaching efforts. Perhaps the best resource for learning what videodisc material is available on the market is *The Videodisc Compendium for Education and Training* published by Emerging Technologies Consultants, Inc. The videodisc information that follows was drawn from that publication. Each entry in our listing includes the title, a *brief* overview of the content, the vendor, and the vendor's telephone number. The *Compendium* contains a more detailed description of the material. For information concerning the *Compendium* or for assistance in locating appropriate videodisc material, contact Richard Pollak, Emerging Technology Consultants, Inc., P.O. Box 12444, St. Paul, MN 55112, telephone: (612) 639-3973.

ANATOMY AND PHYSIOLOGY

Anatomy and Physiology of the Heart 24 modules covering various aspects of normal and abnormal cardiac anatomy and physiology. *Compatible with:* IBM InfoWindow *Vendor:* British Columbia Institute of Technology (604) 432-8376

Cardiovascular Lab Simulation Simulation of experiments in cardiovascular physiology. Covers experimental preparation, autonomic control, cardiac catheterization, positive pressure ventilation, fibrillation, manometer experiments, the normal and abnormal cardiac cycle, and euthanasia. *Compatible with:* IBM InfoWindow or Matrox VGO-AT overlay board; Pioneer LD-V4200 or LD-V6000 *Vendor:* Dr. Charles Branch, Auburn University (205) 844-5414

Life Sciences Sides 5-6: The Frog Contains anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Living Textbook - The Frog Interactive MultiMedia Library Contains slides and movie clips covering all basic concepts in the anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Mammalian Heart/Lungs Explains structure and function of the mammalian heart by using the hearts of a sheep and dog. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 785-4111

Regulating Body Temperature (2nd Ed.)/ Digestive System (2nd Ed.) Deals with temperature regulation in vertebrates and the mechanical and chemical processes of digestion. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

Respiratory System/Endocrine System Live action shots and animation to show how the body takes in oxygen and expels carbon dioxide. Uses detailed animation to provide data concerning the major endocrine glands and their hormones. *Compatible with:* Any player *Vendor:* Encyclopedia Britannica Ed. Corp. (800) 554-9862

Work of the Heart (2nd Ed.)/Muscles: Structure and Function Animated footage illustrates the parts of the heart and how they relate to the work of the lungs, arteries and veins. Muscle portion deals with the three types of muscles. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

BIOLOGY - GENERAL

Bio Sci Videodisc A visual presentation on the broad scope of biology. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Frogs and How They Live Shows how frogs see, hear, taste, and smell. Illustrates complex ecosystem of the pond and complete metamorphosis of a frog from a tadpole. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 785-4111

Life Cycles Visual record in both motion picture and still frame images of how life begins. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Life Science Biology I and II Deals with effects of temperature and pressure on respiration rates of a series of organisms and examines the influence of climatic environments on the characteristics of plants and animals. *Compatible with:* IBM-PC; Pioneer LDV-6000 series *Vendor:* GPN (800) 228-4630 (402) 472-2007

Life Science Sides 1-4: Molecular, Cell, Human, Plant and Animal Biology Provides broad basic coverage of all topics in life science/biology. *Compatible with:* Pioneer LDV-2000 or 4020 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

Lifetimes of Change: Development and Growth Uses human, animal and plant life examples to cover birth, growth, change, and decay. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 785-4111

Relationships Covers relationships among organisms including parasites, colonies, social insects, predators, prey and competition. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

Reproduction in Organisms 3-part program covering egg laying and hatching in turtles, snails, insects, and a nudibranch; explains sexual forms of reproduction; and explains asexual reproduction. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 785-4111

The Bio Libe Encyclopedia Contains 6000 color frames of over 5000 plant and animal species accessible by Genus species names. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (612) 644-7802

The Living Textbook - Life Science Interactive MultiMedia Library Contains more than 2,700 slides and 164 movie clips covering all basic concepts in life science/biology taught at the secondary and college levels. *Compatible with:* Apple IIGS or Macintosh; Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

Videodisc in Science Education Four units of instructional materials included on the disc, suitable for use in most introductory high school and college biology courses. *Compativle with:* Any player *Vendor:* Waterford Institute (801) 373-2009

BIOTECHNOLOGY

Biotechnology: Learning the Techniques Step-by-step presentations of 33 standard laboratory protocols. *Compatible with:* Any player *Vendor:* GPN (800) 228-4630 (402) 472-2007

BOTANY

Exotic Plants: A Videodisc Compendium Contains over 2,000 high quality color photographs of tropical, subtropical and other exotic plants. *Compatible with:* Any player *Vendor:* VT Productions (408) 438-3100

Landscape Plants Over 7,400 views of over 900 species or varieties of cultivated woody plants. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Living Trees/The living Soil Defines and describes the parts and functions of trees. Illustrates the forces that create the soil and the many organisms that use and enrich it. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 785-4111

Pollination Biology Documentary dealing with all facets of flower pollination. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

CELL BIOLOGY

Cell Biology I: Motion and Function of the Living Cell Includes film sequences and still images covering cell types, cell constituents, mitosis and cytokinesis, fission and cell motility. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Meiosis (2nd Ed)/Mitosis (2nd Ed) Microscopic footage and animation dealing with the processes of meiosis and mitosis. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

CLINICAL MEDICINE

Abdominal Stab Wounds Simulation designed to teach the initial assessment process. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Active Knee Series A library of programs examining the diagnosis of knee injuries by any person who is first to respond. *Compatible with:* IBM InfoWindow, Sony and other players *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

American Heart Association: Airway Management Basic non-invasive and specialized invasive procedures of airway management. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Arrhythmia Recognition Material from American Heart Association ACLS text, ECG lessons, ECG static and dynamic examples. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Cardiopulmonary Resuscitation Teaches and tests in CPR and Basic Life Support *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Circulatory Adjuncts and Resuscitation Pharmacology Teaches basic techniques of starting IVs, patient defibrillation and cardioversion, and external and transvenous pacin. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Megacode Trains individuals in organizing and managing cardiac emergencies through simulations. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

An Introduction to Cardiovascular Examination Covers anatomy and physiology of the heart, ascultation of heart sounds and abnormal heart sounds and murmurs. *Compatible with:* Any player *Vendor:* Mirror Systems (617) 491-5336

A Patient with Diarrhea and Vomiting Presents a patient in the emergency department with flu-like complaints of vomiting and diarrhea. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Assessment of Neuromotor Dysfunction in Infants Covers the 5 parameters of assessment to determine if infants up to 18 months old are normal or have a neuromoter abnormality. *Compatible with:* IBM PC with color monitor, Macintosh; Pioneer LD-V4200, V6000 *Vendor:* Cognitive Design Technologies (319) 337-8109

Auscultation of Normal Breath Sounds Reviews standard procedures to auscultate the posterior and anterior chest, patient positions, breathing techniques and stethoscope placement. It also reviews intrathoracic dynamics and the physical dynamics of chest tubes. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Balancing for Diabetic Control Designed to teach students principles of diabetic management. Two case studies are presented. *Compatible with:* IBM-PC compatible and Pioneer LDV-6000 series *Vendor:* Stewart Publishing, Inc. (703) 354-8155

Cardiovascular Resources Videodisc Contains a large collection of materials that may be used to teach cardiovascular nursing and medicine. *Compatible with:* any player *Vendor:* University of Washington (206) 545-1186

Care Basics for Nursing Assistants Introductory course to meet training needs of nursing assistants working in longterm care. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems, Online GL512, VAL *Vendor:* Professional Training Systems, Inc. (404) 872-9700

Central Venous Pressure/Antishock Trousers Defines the CVP manometer and its 4 functions. Defines the purpose and components of Antishock Trousers. *Compatible with:* IBM InfoWindow, Sony, EIDS, FITNE; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Chest Trauma Presents a patient with respiratory distress and hypovolemic shock resulting from multiple injuries sustained in a car accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Cyanotic Premature Babies Presents 5 cases of premature, cyanotic infants in respiratory distress at the moment of, or soon after, delivery. *Compatible with:* Any player *Vendor:* Health Sciences Consortium (919) 942-8731

Diagnostic Decisions in a Patient in Shock Presents a challenge in differential diagnosis of emergency department patient with general early complaints that progresss to suggest upper gastrointestinal bleeding and/or acute myocardial infarction. *Compatible with:* IBM Info Window, Sony, EIDS, FITNE; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Dysrhythmia Training and Evaluation Designed to train students in electrocardiography with a focus on dysrhythmia recognition. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Emergency Simulation designed for paramedics, emergency medical technicians, emergency physicians, nurses, and others with a background in emergency training. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers Inc. (403) 462-6365

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

BIOLOGY COURSEWARE FOR COLLEGE FRESHMEN: THE SEQUEL 17
Charles L. Ralph

KEEPING ABREAST OF THE LITERATURE 20

WHERE ARE THE VIDEODISCS? – PART 2 20

BIOLOGY COURSEWARE FOR COLLEGE FRESHMEN: THE SEQUEL

Charles L. Ralph
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In a previous communication, I reported on my experience using proprietary instructional software (courseware) with freshman biology classes and progress in developing *de novo* a large set of software for these classes.[4] This report provides additional details about the Biology Instruction Computer Enhanced Project (BICEP),[3] updates our progress in developing courseware programs, and announces the availability of the programs to educational institutions.

EFFECTIVENESS OF THE COURSEWARE

The earlier article described a test of teaching effectiveness of the courseware with a typical class of freshman biology students. At that time, a statistical analysis of the data had not been completed, but it was noted that there appeared to be no difference between the half of the class that were exposed to our courseware and did not have have a traditional hands-on laboratory and those that did have a traditional laboratory and were not exposed to the courseware. The analysis has been completed, and it shows that, when the scores on an examination of knowledge of biology which was given on the first day of class is factored in, the computer-using group performed better,

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in terms of final grade, at the 0.05 significance level.

We have collected, formally and informally, much anecdotal information from the students using our courseware, and it suggest that they are strongly in favor of substituting courseware programs for a traditional laboratory, and they believe that their learning and understanding is greatly improved by this mode of teaching. Indeed, the design we are using, wherein the courseware laboratory (two programs in each 2-hour period per week) is required of all students, and the practicum (hands-on) laboratory is optional and does not contribute to the course grade, has been accepted remarkably well by the students. My class section is one of three in the first semester biology course and the only one that uses this format; the other two include a practicum-type, weekly 2-hour laboratory. It has come to my attention by those in charge of course changes that they are experiencing an increasing number of students requesting placement in the section that employs courseware. The number of requests is not quantified and may be small, but it is still an interesting happening, in view of how little information is available to entering freshmen about the exact format of courses at this university.

The self-selection by students of the practicum component has the beneficial effects of sorting for students that want the hands-on experiences, greatly diminishes the size and number of laboratory sections, reduces the cost of materials, and allows those students with ethical or moral objections about use of animals in student laboratories to avoid participation. Furthermore, in some instances, the computer can provide an active learning experience that is equal to or better than the traditional student laboratory, an argument that others have supported.[1] For example, we do, at most, two runs of the experiment using catalase to produce oxygen from hydrogen peroxide in the traditional laboratory, with only temperature change as the variable. In the computer program that simulates this experiment, the amount of substrate, enzyme concentration, and temperature are all variables, with four or five simulations done for each, as well as a simulation on the effect of an enzyme inhibitor. I know the argument that students need to experience "real" laboratories, but I find little satisfaction in forcing reluctant students to participate in activities to which they bring negative and disruptive attitudes. Furthermore, students remaining in the biological sciences will be exposed to many "real" laboratories as they advance through their programs, and unless they become will informed and grasp a host of arcane and complex concepts quickly in the freshman year, they will not be around to appreciate those "real" freshman laboratories. I am convinced that the courseware exposure is a much better, more informative and more efficient use of the weekly laboratory period for freshman students than is the traditional laboratory.

Just how the courseware is used obviously influences its effectiveness. For instances, there is a multiple-choice quiz at the end of each program. It is intended to reveal to the students their relative understanding of the program's information. If they do not do well on the quiz, they are directed to review the topics in which they missed questions. Some students do review and some do not, even though most have time to do so, either during the scheduled laboratory or in later make-up sections. The courseware laboratory provides a benefit in terms of being readily available for repetition or make-up of missed laboratories. Any program can be requested by the student at any time during the course. The only restriction is that they must be viewed in one of the scheduled periods, but there are 15 laboratory periods per week, at various times of day, in which they can be accommodated.

THE BASIC BIOLOGY COURSEWARE SET

In the summer of 1988, I began to produce a set of complementary courseware programs for use in the freshman biology year. The set was completed last summer and includes 52 titles, allowing the use of two programs per week in each of the 2-hour, 13-week laboratories per each of two semesters. These programs cover topics typically taught in basic biology courses. The topic list is presented in Table 1.

Our ability to create so many programs in a remarkably brief time is largely due to the efficiencies of creation with the iconographic authoring program used (Authorware Professional) and the splendid creativeness of the students who produced most of the programs.[4] Several faculty colleagues have provided critical expertise and assisted with editing the programs.

The subjects for programs have been selected to parallel a typical, basic course in biology. Those topics that can be explained particularly well through graphic explanations have been especially emphasized. For example, the flow of electrons in the photosystems of photosynthetic plants or in the mitochondria of aerobic organisms are especially amenable to animated, graphic descriptions. The programs also do very well in progressively building complex diagrams by incremental additions of components, rather than presenting them all at once as in static illustrations. For holistic learners, we suspect, the graphic computer screen with mobile objects is particularly good for instruction.

Although the programs were specifically developed for use in the first-year biology courses at Colorada State University, this large library should provide topics suitable for a variety of basic biology courses at the university level or senior high school level. In fact, one of the local high schools is using the complete set of programs in a seniors class.

Modell states "to be completely successful, a critical mass of high quality software covering all aspects of a given discipline must be available. This pool must contain software that is versatile

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Table 1. Titles of programs in the Basic Biology Courseware Set.

Biochemistry
Cells
Membrane Permeability
Enzyme Kinetics
Oxidation-Reduction
ATP Synthesis
Photosynthesis I
Photosynthesis II
Mitosis
Meiosis
Genetic Experiments
Molecular Genetics
Protein Synthesis
Viral and Bacterial Genetics
Eukaryotic Gene Expression
Genetic Engineering
Microevolution
Macroevolution
Animal Reproduction
Animal Development
Adaptations
Biomes
Population Growth
Communities
Ecosystems
Behavior
Classification of Animals
Invertebrates
Chordates
Animal Structure
Digestive Enzymes
Countercurrent Exchange
Respiration
Immune System
Osmoregulation
Kidney Function
Hormonal Regulation
Blood Glucose
Neural Transmission
Muscles
Seeds and Seedlings
Plant Hormones
Primary Growth
Secondary Growth
Leaves
Monera
Protista: Heterotrophs
Protista: Autotrophs
Fungi
Reproduction in Non-Seed Plants
Reproduction in Seed Plants
Plant Evolution

enough to be used in different curricula and at different levels of sophistication. To reach this level, faculty must submit their software for peer evaluation ... .”[2] Our Basic Biology Series has the critical mass, and it should be versatile; I hope it will meet the criterion of high quality. By making the programs available to educational institutions and testing their viability in the marketplace, a truly rigorous peer review will be effected.

NATURE OF THE PROGRAMS AND AVAILABILITY

The 52 programs in the Basic Biology Series are compiled Macintosh files created in Authorware Professional. They have a uniform, easy-to-use format that does not require any documentation to operate. Each program has a run time of approximately 45 minutes. Arcane terms are in boldface in the text and are defined, and commonly derived, in a pulldown glossary. Frequent student interactions, including simulations of experiments, text entry for answering questions, and click and drag exercises make the programs lively and interesting. The generous use of graphics and an attractive appearance provide an appealing learning environment.

The programs will run on any Macintosh computer with at least 1 megabyte of RAM. The programs are supplied as individual programs on floppy disks and can be packaged for individual use or for copying onto a multi-user system. They can, by special request, be packaged for use on certain IBM-type computers that are equipped with a mouse-type device. Only the standard system software is required to run them.

The programs are marketed by OmegaWare, a company licensed by Colorado State University. Sales are only to educational institutions. The cost of a single program copy is $20, but multiple-copy rights may be purchased which lowers the price to less than $3 per copy. Contact OmegaWare, P.O. Box 8024, Ft. Collins, CO 80526 for additional information.

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The author thanks the faculty colleagues who have provided critical expertise and assisted with editing the programs. A special thank you is extended to Dr. David W. Kramer, Department of Plant Biology, The Ohio State University, who did a splendid job in editing the plant biology programs.

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WHERE ARE THE VIDEODISCS? – PART 2

Applications of interactive video in life science education continues to grow. As the cost of the technology necessary to implement interactive video falls within the feasibility range of institutions and the interest in Hypermedia continues to grow, more educators are looking for sources of video images or interactive video courseware to use in their teaching efforts. Perhaps the best resource for learning what videodisc material is available on the market is *The Videodisc Compendium for Education and Training* published by Emerging Technologies Consultants, Inc. The videodisc information that follows was drawn from that publication and completes the list presented last month. Each entry in our listing includes the title, a *brief* overview of the content, the vendor, and the vendor's telephone number. The *Compendium* contains a more detailed description of the material. For information concerning the *Compendium* or for assistance in locating appropriate videodisc material, contact Richard Pollak, Emerging Technology Consultants, Inc., P.O. Box 12444, St. Paul, MN 55112, telephone: (612) 639-3973.

CLINICAL MEDICINE CONT'D.

Emergency Cardiac Maneuvers: A Rescuer's Handbook Covers general information, anatomy and physiology, rhythm problems, and rescue maneu-

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vers. *Compatible with:* any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Estrogen Replacement Therapy Covers the reasons for the therapy, details on the therapy, medical evaluation procedures, and the side effects and risks of using this therapy. *Compatible with:* IBM InfoWindow *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Health History/Physical Exam of the Diabetic Clinical simulation followed by an examination. *Compatible with:* IBM-PC, Pioneer LDV-6000 Series *Vendor:* Stewart Publishing, Inc. (703) 354-8155

Initial Assessment of Respiratory Difficulty Presents a patient involved in a motor vehicle accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Intravenous Therapy Teaches intravenous therapy principles and techniques. *Compatible with:* FITNE Interactive System or IBM InfoWindow *Vendor:* Fuld Institute for Technology in Nursing Education (614) 592-2511

IV Therapy/IV Solutions Reviews overall goals of IV therapy and the major types of IV solutions. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Managing the Experience of Labor and Delivery Simulates normal labor and delivery process beginning with admittance to the hospital of the laboring patient and her husband. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Mechanical Ventilators Provides brief overview of 10 mechanical ventilators *Compatible with:* IBM InfoWindow, Sony VIEW, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Motor Vehicle Trauma Simulation takes place in an emergency department, beginning with admission of a multiple trauma patient in hypovolemic shock. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Nursing Care of the Cancer Patient with Compromised Immunity: The Nursing Process Simulates the five steps in the nursing process. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Nursing Care of Elderly Patients with Acute Cardiac Disorders Simulation of a 73 year old with an MJ and treated with rombolytic therapy who develops ventricular fibrillation, and an 80 year old with CHF who develops atrial fibrillation. *Compatitble with:* InfoWindow, FITNE, Sony VIEW, Visage *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 x541

Nursing Care of the Elderly Patient with COPD A case study simulation about a 73-year old man with COPD and pneumonia. *Compatible with:* IBM InfoWindow, FITNE, Sony VIEW, Visage *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

Obstetrics Simulation of the delivery of a baby in a rural community hospital. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Premenstrual Syndrome: A Clinical Manual Covers various areas of PMS from diagnosis and examination to diet and various drug therapies to assist in coping with it. *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Preserving the Treasures of the Heart Presents information on workings of the heart and circulatory system. Explains cardiovascular disease and its effect. Discusses factors that cause cardiovascular disease and emphasizes primary and secondary means of preventing cardiovascular disease. Part 1 for pediatricians. Part 2 for patients and students. *Compatible with:* IBM InfoWindow *Vendor:* The Alive Centers of America (216) 869-9623

Prevention of Occupational Exposure to the AIDS Virus Explains cause of AIDS, how HIV is transmitted, and how health care workers should protect themselves from exposure to the virus. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems, Online GL512, VAL *Vendor:* Professional Training Systems, Inc. (404) 872-9700

Shotgun Wounds to the Abdomen Presents opportunity to assess and manage a patient with shotgun wounds to the abdomen. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Sterile Technique at the Bedside Instructs health-care professionals in the steps for preparing and applying dressings and maintaining sterile techniques in patient care. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (800) 352-8293 (403) 256-1100

Urinary Catheterization Instructs health-care professionals in the preparation of the patient and the tray and proper catheterization techniques. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (800) 352-8293 (403) 256-1100

DENTAL HEALTH CARE

Dental Diagnosis and Treatment: A Videodisc Atlas Represents all oral and dental health care disciplines. Includes dental anatomy, endodontics, family dentistry, oral diagnosis, oral medicine, oral pathology, oral and maxillofacial surgery, orthodontics, pediatric dentistry, periodontics and preventive and community dentistry. *Compatible with:* Any player *Vendor:* University of Iowa (319) 335-9656

HEALTH SCIENCE

AIDS - An Educational Program Provides the essential facts about AIDS and how to avoid contracting the disease. *Compatible with:* IBM InfoWindow *Vendor:* Health Edutech, Inc. (612) 881-1926

The Birth Disc A visual database with over 9,000 images of childbirth from hospitals, birth centers, and home environments. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (612) 644-7802

Hormonal Contraceptions: Pills, Injections and Implants Covers various aspects of hormonal contraceptives *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Infection Control Provides basic information on how an infection is transmitted, how to isolate an infection, and how to prevent an infection from spreading. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems; Online GL512, VAL *Vendor:* Health Edutech, Inc. (612) 831-0445

MDR Shared Disc: Resources III Generic medical images from 8 institutions covering microanatomy, histology, radiology, cardiology, immunology, pathology, neuroanatomy, rheumatology, endoscopy, dermatology, clinical microscopy, nuclear medicine and histology. *Compatible with:* Any player *Vendor:* Stewart Publishing (703) 354-8155

ProCare: How to Be a Nurse Assistant Designed to help prepare nurse assistants in long term care facilities to meed federal and state requirements for certification. *Compatible with:* IHN Pro-Vision System *Vendor:* Interactive Health Network (404) 872-9700

Slice of Life III Over 26,000 still images drawn from various areas of medicine, dentistry and allied health education. *Compatible with:* IBM, Macintosh; Any player *Vendor:* University of Utah (801) 581-8052

Slice of Life IV A visual encyclopedia of more than 32,000 still images pertaining to medicine, nursing, dentistry, and allied health education. Subjects include cardiology, cytology, embryology, gross anatomy, histology, microbiology, neuroanatomy, parasitology, pathology, radiology, and other clinical disciplines. Side 2 contains dental education, normal range of motion for all major joints, and gait sequences. *Compatible with:* IBM, Macintosh, and RS-232 player *Vendor:* University of Utah (801) 581-8694

STD: Sexually Transmitted Diseases Information Program Provides the facts about the eight most common sexually transmitted diseases. *Compatible with:* IBM InfoWindow *Vendor:* Health Edutech, Inc. (612) 831-0445

HEMATOLOGY

Basic Hematology Tutorial, drill and practice, and simulation program that utilizes the "Medical Applications Videodisc: Hematology 2nd Ed. (University of Washington) *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers Inc. (403) 462-6365

Introduction to Case Studies in Hematology A series of 20 case studies designed to acquaint students with basic problem-solving techniques involving cell identification and clinical correlations. *Compatible with:* Macintosh; Pioneer or Sony player *Vendor:* Edudisc, Inc (615) 373-2506

Laboratory Medicine Video Library: Atlas of Hematology Contains over 6,000 images forming a comprehensive library of hematologic findings which can be used for education, testing and reference. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Medical Applications Videodisc: Hematology, 2nd Edition Contains the entire American Society of Hematology morphology collection, the World Health Organization International Histologic Classification of Tumors, frames from the Western Universities' Physical Diagnosis Slide Bank, and extensive morphological study of acute leukemias, and the film "Red Cell Shapes" *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

MICROBIOLOGY

Microbes: Bacteria and Fungi Examines the physical characteristics, the risky and beneficial applications, and ways to impede and prevent growth of microbes. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467

Viruses: What They Are and How They Work/Bacteria Explores the structure, reproduction and lifestyles of these sometimes harmful but often beneficial organisms. *Compatible with:* Any Player *Vendor:* Encyclopaedia Britannica Ed. Corp. (800) 554-9862

PATHOLOGY AND PATHOPHYSIOLOGY

Acute Leukemia Morphology II Contains numerous exemplary peripheral blood smears, bone marrows and special stains for instruction and reference in the differentiation of acute leukemias. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Bone Pathology Covers 70 bone diseases, including 1900 pictures. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

Breast Pathology Provides information about 77 breast diseases, including 1300 disease slides and 900 feature

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slides. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

Cardiology Series A 12 disc course designed to develop in a logical way the consequences following the creation or establishment of heart defects. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Disorders of the Nervous System: Mentation Six patients are shown who demonstrate a variety of disorders of mentation. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Disorders of the Nervous System: Motor A compilation of material from a "visual glossary" collection of neurological dysfunction. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

International Veterinary Pathology Slide Bank, Ed. 4 Contains still frames of lesions from domestic, laboratory and wild animals from contributors in the U.S., Canada, and Europe. *Compatible with:* IBM-PC; Pioneer LDV-4200 *Vendor:* University of Georgia (404) 542-5837

Lymph Node Pathology Provides information on 63 diseases, including approximately 5,000 pictures. Performs differential diagnosis with detailed explanations. Automatically generates surgical pathology report. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

Management of Heart Failure Covers the definitions and causes of heart failure, the signs and symptoms, pathophysiology and therapy. *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Pathophysiology of Shock/Pathophysiology of Cardiac Tamponade Looks at physiologic effects of shock and the body's compensatory responses to the syndrome. Provides 3 cases that demonstrate how cardiac tamponade presents itself and when to suspect tamponade. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Stomach Pathology Covers 54 diseases of the stomach with 1200 pictures. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

Thymus-Mediastinum Pathology Covers 46 Thymus-Mediastinal diseases using 1000 pictures. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

Thyroid Cytology Contains 400 pictures on 18 diseases. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

WILDLIFE MANAGEMENT

Yellowstone in Winter Provides insight into the work of Yellowstone's rangers in their management of wildlife. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

ZOOLOGY

Encyclopedia of Animals Eight discs covering mammals, birds, reptiles, insects, and marine life. *Compatible with:* Any player *Vendor:* Pioneer LDCA, Inc. (213) 835-6177

Whales Motion footage and still pictures to take students into the underwater world of whales. *Compatible with:* Pioneer LDV-6000 series Level II, Any player Level 1 *Vendor:* National Geographic (800) 368-2728 (301) 921-1330

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

WHERE'S THE SOFTWARE? – PART 1 25

WHERE'S THE SOFTWARE? – PART 1

In the past, we have published lists of life science software sources and programs available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

The listings are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on page 30.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

ANATOMY

ANATOMY OF A FISH
Tutorial/game presenting information on the external, internal, and skeletal structures of a bony fish. Available for Apple II compatible equipment.
VENTURA EDUCATIONAL SYSTEMS

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM
Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment.
WILLIAMS & WILKINS

ANATOMY OF A SEA LAMPREY
Tutorial/game presenting information on the life cycle and anatomy of a sea lamprey. Available for Apple II compatible equipment.
VENTURA EDUCATIONAL SYSTEMS

COCHLEAR ANATOMY: A MACINTOSH TOUR
HyperCard courseware that provides an anatomical tour through the hearing portion of the mammalian inner ear. Available for Macintosh equipment.
INTELLIMATION FOR THE MACINTOSH

BODY LANGUAGE I, II, III, IV
A series of drill and practice reviews of anatomical terms. Available for Apple II and IBM-PC compatible equipment.
EDUCATIONAL SOFTWARE PRODUCTS

GROSS ANATOMY TUTORIAL
Tutorial for gross anatomy review by region and for self-test in National Board format. Program available for Apple II equipment.
LIFE SCIENCE ASSOCIATES

0742-3233/91/$0.00 + 2.00

HEART LAB
Animated graphics simulation of human heart. Program available for Apple II, TRS-80 Models I and III, PET, and Atari 800/800XL equipment. EDUCATIONAL ACTIVITIES, INC.

HUMAN ANATOMY PICTURE FILE
Hi-Res diagrams of heart, brain, eye, ear, respiratory system, kidney, endocrine system, neurons, circulatory system schematic, and digestive system. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

LOCOMOTION
Tutorial reviewing types and functions of bones and muscles. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

NEUROANATOMY FOUNDATIONS
HyperCard based computer atlas of brain anatomy. Includes digitized images of three-dimensional dissections, diagrams, and text. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

BIOCHEMISTRY

ANIMATED PATHWAYS OF BIOCHEMISTRY
Simulation of molecules colliding and reacting. Available for IBM-PC compatible equipment. WILLIAMS & WILKINS

ANIMATIONS
Contains animations for demonstrating DNA structure and synthesis, RNA structure and synthesis, and protein synthesis. Program available for Apple II equipment. ALBION

BIOCHEMISTRY
Tutorial covering basic atomic structure, balancing equations, and properties of proteins and carbohydrates. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOCHEMISTRY EXAM/TUTORIAL
Covers basic fuel metabolism. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

CONCENTRATED CHEMICAL CONCEPTS: BIOLOGICAL CHEMIST
Drill and practice program covering an entire introductory course in organic chemistry for health science majors. WILEY PROFESSIONAL SOFTWARE

DNA STRUCTURE AND SYNTHESIS
Tutorial dealing with nucleotide structure and linkage between nucleotide, base complementarity and hydrogen bonding. Program available for Apple II equipment. EDUTECH, INC.

DNA-THE BASICS
Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

ENZKIN: Enzyme Kinetics
Simulation of enzyme-catalyzed reactions. Program available for Apple II equipment. CONDUIT

ENZLAB
Simulations for designing and carrying out enzyme kinetics experiments. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

ENZPACK
An enzyme kinetics teaching and calculation program. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

ENZYMATIC ACTION
Simulation that allows students to investigate the optimum condition for the digestion of starch by the enzyme salivary amylase. Available for IBM-PC compatible equipment. WISC-WARE

ENZYME ACTION
Tutorial on the basic nature and function of enzymes. Program available for Apple II equipment. BIOSOFT

ENZYME-SIMULATION, ENZYME ACTION
Simulation of enzyme action and the effects of inhibitors using acetylcholinesterase. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GENE MACHINE
Tutorial/Simulation dealing with DNA replication and protein synthesis. Program available for Apple II equipment. HRM SOFTWARE

MOLECULAR BIOLOGY SERIES
Programs demonstrating central processes of RNA and protein synthesis and DNA synthesis and repair. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

MOLGRAF
Molecular graphics package. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

THE NUCLEIC ACIDS
Tutorial/Simulation dealing with principal nucleotides and synthesis of RNA. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

PROTEIN SYNTHESIS
Tutorial dealing with the general structure of the amino acids and formation of peptide bonds. Program available for Apple II equipment. EDUTECH, INC.

RNA STRUCTURE AND SYNTHESIS
Tutorial extending the concept of hydrogen bonding between complementary bases to show the synthesis of RNA on the DNA template and the analogies in structure between DNA and RNA. Program available for Apple II equipment. EDU TECH, INC.

BIOLOGY

ADAPTION AND IDENTIFICATION
Tutorial covering animal adaptation to different environments and animal identification. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ANIMAL REPRODUCTION
Tutorial reviewing sperm development, egg and fertilized egg. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

ANTS - RELIABILITY THEORY & ANT FORAGING MODEL
An interactive program to study the system reliability of different ant foraging strategies. Available for IBM-PC compatible equipment. WISC-WARE

ASEXUAL REPRODUCTION
Tutorial reviewing cell division. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOLOGY 1/BIOLOGY 2
Tutorials covering a wide range of topics in biology. Available for IBM- PC compatible equipment. INTELLECTUAL SOFTWARE

BIOLOGY COMPUTER STIMULATIONS
Tutorial covering various biological concepts and experimental areas including enzymes, photosynthesis, respiration, diffusion, meiosis, muscles, nerves, and genetics. Program available for Apple II and TRS-80 Models I

and III equipment. LIFE SCIENCE ASSOCIATES

BIOLOGY COURSEWARE

Series of 52 tutorial and simulation programs covering most topics covered in a two-semester, freshman biology course. Available for Macintosh equipment. OMEGAWARE

BIOLOGY DISSECTION FROG

Dissection guide that teaches students how to dissect a frog. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY LAB DISSECTIONS

Seven dissection guides teach students about seven different animals: Frog, Earthworm, Grasshopper, Crayfish, Starfish, Clam and Perch. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY SIMULATIONS PACKAGE III

Three collections of simulations covering aspects of genetics, natural selection, and predator-prey interaction. Available for Apple //e (enhanced) equipment. ALBION

CELLS

Simulation of experiments in tracking the movement of cells through the four-state mitotic cell cycle. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

CREATE A TEST/CREATE A TEST QUESTION FILES-BIOLOGY

Test creation program and 4800 question bank in biology. Available for Commodore 64, Apple II and IBM-PC compatible equipment. CROSS EDUCATIONAL SOFTWARE

DIFFUSION AND ACTIVE TRANSPORT

Tutorial covering diffusion, osmosis, and active transport in biological systems. Program available for Apple II equipment. SIMPAC EDUCATIONAL SYSTEMS

EFFECT OF SIZE ON MOUSE METABOLISM

HyperCard stack that describes the effects of mouse size on the metabolic rate. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

ENERGETICS AND METABOLISM, GARDEN OF BIOLOGY: VOLUME I

Data base illustrating reactions of metabolism and interactions between the several metabolic compartments of a cell. Program available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

EVOLUTION, GARDEN OF BIOLOGY: VOLUME 2

Data base illustrating relations among organisms of many kinds, emphasizing the history and mechanics of their evolutionary change. Program available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

EXPERIMENTS IN BIOLOGY

Three programs designed to accompany student laboratory exercises in biology covering respiration, diffusion and surface volume ratio. Data from experiments are entered and class results are presented in table format. Available for DEC equipment. THE CLEARINGHOUSE

FASCINATING STORY OF CELL GROWTH

Tutorial covers surface area/cell volume, experimenting with cell size, chromosomes in cell division and stages of mitosis. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HOW'S AND WHY'S OF MIGRATING MOLECULES

Tutorial covering transport through a membrane, osmosis and diffusion. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HUNTINGTON I SIM PROG - BIOLOGY

Seven simulations for use in introductory level biology courses. Available for DEC equipment. HUNTINGTON COMPUTER PROJECT

KNOWLEDGE MASTER - BIOLOGY 2

Test-item database for test generation. Content covers coelenterates, arthropods, insects, fish, amphibians, and reptiles. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

KNOWLEDGE MASTER - BIOLOGY 3

Test-item database for test generation. Content covers birds, mammals, primates, protists, bacteria and taxonomic zoology. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

MACFROG

Interactive laboratory that simulates a frog dissection. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MARINE INVERTEBRATES

Tutorial covering animals from the Phylums Porifera, Mollusca, Coelenterata, and Echinodermata. Avaialable for Apple II equipment. VENTURA EDUCATIONAL SYSTEMS

OSMO- OSMOSIS IN RED BLOOD CELLS

Simulation of red blood cells in hypertonic, hypotonic, and isotonic solutions. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

OSMOSIS AND DIFFUSION

Tutorial/Simulation covering effects of temperature, concentration, solubility, molecule size and charge, and membrane pore size on flow of matter across semi-permeable membranes. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

OSMOTIC PRESSURE

Simulation of thistle tube experiments and animation of a molecular model for osmosis. Program available for Apple II equipment. CONDUIT

PASSIVE TRANSPORT

Tutorial-simulation covering diffusion and osmosis. Program for MS-DOS compatible equipment. CLASSROOM CONSORTIA MEDIA, INC.

PLANT AND ANIMAL CELLS

Tutorial covering the general structure of plant cells, photosynthesis, the genral stucture of animal cells, and mitosis. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

SIMULATION OF HEMOGLOBIN FUNCTION

Simulations of hemoglobin and myoglobin functions. Program for Apple II equipment. QUEUE, INC.

THE INSECT WORLD

Simulation/tutorial covering insect types, body parts, and survival. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

BOTANY

ALGAL GROWTH

Simulation of the effects of eight variables on growth of algae. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

BIOLOGY FRUIT KEY

Identifies 125 trees and shrubs. Program available for Atari 400/800 equipment. DYNACOMP, INC.

BOTANY ON DEC

Three data analysis programs to accompany student laboratory experiments in plasmolysis, respiration and surface-volume ratio. Available for DEC equipment. THE CLEARINGHOUSE

COMPETE:Plant competition

Simulation of experiments involving interaction between flowering plants. Program available for Apple II equipment. CONDUIT

EARLY ANGIOSPERMS: A FOSSIL VIEW

Tutorial utilizing the fossil record to explain the development of flowering plants. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

EPIGRAPH - -PLANT DIESASE EPIDEMIC SIMULATION

Simulation designed to teach students some basic concepts in disease epidemiology. Available for IBM-PC compatible equipment. WISC-WARE

EXPLORING THAT AMAZING FOOD FACTORY, THE LEAF

Tutorial covers transport in the leaf, structure of the leaf and stomate action in gas exchange. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

FAMILY IDENTIFICATION

Data retrieval program to review the characteristics of 74 North American flowering plant families. Program available for Apple II equipment. CONDUIT

HOW PLANTS GROW: THE INSIDE STORY

Tutorial covers growth of the plant, stem cross section, terminal bud and plant hormones. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

LEAF: STRUCTURE AND FUNCTION

Tutorial-simulation covering the anatomy and physiology of the leaf with respect to its role as the "chemical factory" of the plant. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PHOTOSYNTHESIS AND LIGHT ENERGY

Simulation focuses on characteristics of light and its role as an energy source. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PHOTOSYNTHESIS AND RESPIRATION

Demonstration and simulations focusing with light and dark reactions of photosynthesis, respiration, and ATP cycle. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

PHOTOSYNTHESIS & TRANSPORT

Tutorial dealing with photosynthesis and transport in plants. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

PHOTOSYNTHESIS: UNLOCKING THE POWER OF THE SUN

Tutorial includes light as energy, light characteristics, wave length of light used by chromoplasts, variables and controls. Available for IBM- PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

PLANT ANATOMY PICTURE FILE

Hi-Res diagrams of roots, stem cross-section, leaf cross-section, photosynthesis, flowers, seeds, and germination. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

PLANT GROWTH

Tutorial-simulation covering physiology of growth beginning with the seed. Covers hormone control, feedback mechanisms, transport, and differentiation. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PLANT LIFE CYCLE GAMES

Four short drill programs cover the life cycles of mosses, ferns, and gymnosperms, and angiosperms. Available for DEC equipment. THE CLEARINGHOUSE

PLANT PAINT 2.0

A set of 72 graphics images illustrating concepts in plant biology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

PLANT-PLANT GROWTH SIMULATION

Simulation of the effects of light intensity and duration on growth and development of green plants. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

PLANT ROOT MODEL

Graphically illustrates the control a root has over the rhizosphere. Available for IBM-PC compatible equipment. WISC-WARE

PLANT STACKS

HyperCard tutorial allows student to view the basic processes and structures as they appear in plants. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

PLANTID

Tutorial introduces identification and taxonomy of woody plants. Available for DEC equiopment. THE CLEARINGHOUSE

REALTREE – FRACTAL SIMULATION OF TREE GROWTH

Presents a simple fractal model, capable of drawing a hugh variety of tree-like shapes with variation in a few parameters. Designed as an exercise in an undergraduate Field Biology course. Available for IBM-PC compatible equipment. WISC-WARE

REPRODUCTION IN PLANTS

Tutorial reviewing asexual and sexual reproduction in plants. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

SEXUAL REPRODUCTION IN PLANTS

Tutorial covering plant reproduction including meiosis, gamete formation, reproduction cycles, and alternation of generations. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

SOLAR FOOD

Tutorial/Simulation dealing with photosynthesis. Program available for Apple II equipment. HRM SOFTWARE

THE PLANT - NATURE'S FOOD FACTORY

Tutorial/simulation covering flowers, leaves, stems, roots, and cells. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

CLINICAL MEDICINE

ABG PRACTICE/THE ABG TEACHER

Drill and practice and tutorial programs dealing with acid/base evaluation. Available for Apple II and IBM- PC compatible equipment. MEDSOFT

AHB - ABNORMAL HUMAN BIOLOGY CLINICAL TUTORIALS

Tutorial organized as 12 separate lessons. Program presents a situation requiring a diagnosis and asks what tests the student would perform, providing informational and numerical feedback along the way. Available for IBM-PC compatible equipment. WISC-WARE

ALCOHOL ABUSE AND ALCOHOLISM

Set of eight patient-management problems simulating the treatment of patients with alcohol related problems. Available for Apple II and IBM- PC compatible equipment. UMKC SOFTWARE SERIES

ARRHYTHMIAS: CASE STUDIES IN MANAGEMENT

Simulated patients with various cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

ARRHYTHMIAS TUTORIAL I/ TUTORIAL II

Tutorial dealing with all major cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

ARTERIAL BLOOD GASES

Tutorial dealing with the interpretation of arterial blood gases. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

ARTERIAL BLOOD GAS ANALYSIS

Tutorial/drill and practice program designed to sharpen clinical skills in assessing blood gas levels. Available for IBM-PC compatible and Macintosh equipment. DECKER ELECTRONIC PUBLISHING INC.

BLANCHAER CLINICAL CASE STUDIES

Eight simulations of clinical syndromes. Program available for Apple II equipment. BIOSOFT

BLOOD COUNTS & DIFFERENTIAL EVALUATION – TEACHING MODULE

Test proficiency in the interpretation of blood counts. Available for IBM- PC compatible equipment. LEA & FEBIGER

BLOOD GASES

Tutorial covering blood gas interpretation. Available for IBM-PC compatible, Apple II, and Macintosh equipment. MAD SCIENTIST SOFTWARE

BUILDING A MEDICAL VOCAB - COURSE

Tutoria/drill covering basic word parts from which medical terms are built. Available for Apple II and IBM-PC compatible equipment. W.B. SAUNDERS CO.

BUILDING MEDICAL VOCAB - REV COURSE

Tutorial/drill reviewing medical terms. Available for Apple II and IBM-PC compatible equipment. W.B. SAUNDERS CO.

CARDIOLOGY

Study/review package dealing with various aspects of cardiovascular disease. Available for Apple II and IBM-PC compatible equipment. UMKC SOFTWARE SERIES

CHEST PAIN: AN EXERCISE IN CLINICAL PROBLEM SOLVING

Patient management problems dealing with chest pain. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

CLINICAL SCIENCES

Self-assessment package covering internal medicine, ob/gyn, pediatrics, preventive medicine and public health, psychiatry, and surgery. Available for Apple II and IBM-PC compatible equipment. UMKC SOFTWARE SERIES

DOSE CALC

Tutorial covering basic math skills and drug dosage calculations. Available for Apple II compatible equipment. W.B. SAUNDERS CO.

DRUG INTERACTIONS

Computer tool providing access to clinically significant interactions between 600 generic and 1,400 brand-name drugs. Available for IBM-PC compatible equipment. W.B. SAUNDERS CO.

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

EMERGENCY MEDICAL ENGLISH

Practice and reinforcement program to provide exposure to language data emphasized in emergency medical technician training. Available for IBM-PC compatible equipment. WISC-WARE

GAS MAN

Simulation of uptake and distribution of inhalation anesthetics in a 70 kg subject. Available for Apple II compatible equipment. MEDMAN SIMULATIONS

GASMAN

Simulation dealing with the principles of inhalation gas uptake. Available for Apple II compatible equipment. ADDISON-WESLEY PUBLISHING CO.

INSTITUTIONAL PATIENT SIMULATION

Simulation designed to develop and enhance medication problem solving skills. Available for IBM-PC compatible equipment. WISC-WARE

LEARNING CARDIAC ASCULTATION

Tutorial focusing on a broad range of cardiac abnormalities. Available for IBM-PC compatible equipment. WISC-WARE

MANAGING PATIENTS WITH NEUROLOGICAL PROBLEMS

Simulation of 6 cases providing practice and experience in diagnostic reasoning skills by demonstrating the needs of patients and the effects of nursing intervention. Available for Apple II and IBM-PC compatible equipment. W.B. SAUNDERS CO.

MED-CAPS DIAGNOSTIC PROBLEM SOLVING CASES/MANAGER

Case simulations covering a wide range of clinical problems. The manager consists of a set of programs for monitoring student use and performance on the diagnostic problems. Available for Apple II and IBM-PC compatible equipment. HEALTH SCIENCES CONSORTIUM

MEDICOMP: COMPUTER TUTORIAL SERIES

A series of 16 tutorials designed to help students review various key areas of clinical pathology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

PHYSIOLOGICAL TEST DATABASE

Database for Dbase III plus environment that includes diagnostic information about the use and methodology of 288 tests in clinical chemistry, hematology, immunology, microbiology, physiology and urinalysis. Available for IBM-PC compatible equipment. WISC-WARE

STEDMAN'S MEDICAL DICTIONARY

Tool containing a main dictionary and two supplemental dictionaries. Apple

II compatible equipment. SENSIBLE SOFTWARE, INC.

THE SURGEON
Simulation of surgical correction of an aortic aneurysm. Available for Macintosh equipment. INFORMATION SYSTEMS FOR MEDICINE, INC.

CYTOLOGY

CELL CHEMISTRY I
Tutorial covering various chemical structures. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

CELL CHEMISTRY II
Tutorial covering the chemical and physical processes that occur within cells. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

CELLGROW
Simulation of cell kinetics. Program available for Apple II equipment. UNIVERSITY OF TEXAS SYSTEM CANCER CTR

CELL GROWTH AND MITOSIS
Interactive simulation covering surface area-volume ratio, chromosome number, chromosome replication, and cytoplasmic division. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

CELLS
Simulation of experiments in tracking the movement of cells through the four-state mitotic cell cycle. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

CELLS: STRUCTURE AND FUNCTION
Simulation reinforces basic concepts of cell structure, cell functions, water movement and concentration gradients, and diffusion and active transport. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGY

AIR POLLUTION
Simulation of carbon monoxide pollution in an urban environment. Program available for Apple II and TRS-80 Model I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

AQUATIC ECOLOGY
Utilities to perform many of the calculations common to aquatic ecology. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

AQUATIC ECOLOGY DATA SIMULATION
25 simulations covering aquatic systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

ECOLOGICAL DATA SIMULATION
25 simulations covering ecological systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

ECOLOGY
Rote drill reviews and reinforces concepts of general terrestrial, and aquatic ecology. Available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

ECOLOGY
Simulation dealing with plant population sizes and growth pattern. Available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGICAL ANALYSIS - PC
Utilities that perform life table analysis, interspecific association indices, community similarity, diversity indices, descriptive statistics, mark-release recapture analysis, plus regression and correlation analysis. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

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Lea & Febiger
600 S. Washington Square
Philadelphia, PA 19106
(215) 922-1330

Life Science Associates
1 Fennimore Road
Bayport, NY 11705
(516) 472-2111

Mad Scientist Software
13422 North Barberry Circle
Alpine, UT 84004
(801) 756-6027

Medman Simulations
P.O. Box 160
Chestnut Hill, MA 02167
(617) 732-7330

MedSoft
1105 Arondale Drive
Fircrest, WA 98466
(206) 565-5068

New Jersey Medical School
Joseph Boyle, MD
Department of Physiology
100 Bergen Street
Newark, NJ 07103
(201) 456-4464

Oakleaf Systems
P.O. Box 472
Decorah, IA 52101
(319) 382-4320

OmegaWare
P.O. Box 8024
Ft. Collins, CO 80526
(303) 491-7858

Queue, Inc
562 Boston Avenue
Bridgeport, CT 06610
(800) 232-2224

Scott, Foresman and Company
1900 East Lake Ave.
Glenview, IL 60025
(312) 729-3000

Sensible Software, Inc.
335 East Big Beaver
Suite 207
Troy, MI 48083
(313) 528-1950

Simpac Educational Systems
1105 North Main St.
Suite 11C
Gainesville, FL 32601
(904) 376-2049

Siiwa Enterprises, Inc.
2360-J George Washington Hwy
Yorktown, VA 23666
(804) 898-8386

The Clearinghouse
The Computation Center
104 Atanasoff Hall
Iowa State University
Ames, IA 50011-1040
(515) 294-0323

Thoroughbred Educational Software
Division of Queue Inc
562 Boston Avenue
Bridgeport, CT 06610
(800) 232-2224

UMKC Software Series
2411 Holmes Street
Kansas City, MO 64108-2792
(816) 276-1891

University of Texas System Cancer Center
MDAH
Box 6
6723 Bertner
Houston, TX 77030
(713) 792-2581

Ventura Educational Systems
3440 Brokenhill Street
Newbury Park, CA 91320
(805) 499-1407

W. B. Saunders Company
West Washington Square
Philadelphia, PA 19105
(215) 750-1330
(215) 574-3066

Wiley Professional Software
605 Third Avenue
New York, NY 10158
(212) 850-6009

Williams & Wilkins
428 East Preston Street
Baltimore, MD 21202
(800) 638-0672

Wisc-Ware
Academic Computing Center
University of Wisconsin - Madison
1210 West Dayton Street
Madison, WI 53706
(800) 543-3201

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

WHERE'S THE SOFTWARE? – PART 2 33

WHERE'S THE SOFTWARE ? – PART 2

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on pages 38 and 39.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

ECOLOGY (CONTINUED)

ECOLOGICAL ANALYSIS VOL. 2 - PC
Utilities that perform community similarity analysis, indices of dispersion, species-area curve, and step-wise multiple regression. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

ECOLOGICAL ANALYSIS PROGRAMS PLUS
Utilities that perform life table analysis, community similarity indices, diversity indices, predator-prey modeling, mark-recapture analysis, descriptive statistics, plus regression and correlation analysis. Program available for Apple II equipment. OAKLEAF SYSTEMS

ECOLOGICAL MODELING
Series of 7 programs dealing with a variety of techniques for modeling ecological systems and processes. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

GREENHAUS
Tutorial designed to acquaint students with the subject areas of energy, environment, and resources. Available for DEC VAX equipment. THE CLEARINGHOUSE

NICHE-ECOLOGICAL GAME/ SIMULATION
Game in which students attempt to place an organism in its proper ecological niche correctly by specifying envi-

0742-3233/91/$0.00 + 2.00

ronment, range, and competitor. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

POLLUTE

Simulation of factors affecting water quality. Includes temperature, amount and type of pollutant, and water treatment. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

POLLUTE:IMPACT/WATER POLLUTANTS

Simulation of the impact of various pollutants on typical bodies of water. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

WATER POLLUTION

Simulation of the effects of temperature, type of waste, dumping rate, and method of treatment on the impact of pollution on aquatic life. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

EVOLUTION

EVOLUT: Evolution and Natural Selection

Simulation of fluctuations in gene frequencies of wild populations. Program available for Apple II equipment. CONDUIT

EVOLUTION

Simulations covering mutation, gene flow, natural selection, and genetic drift on populations. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

EVOLVE

Simulation of evolution using the Hardy-Weinberg formula and the population model that has evolved from its application. Available for Apple II equipment. CONDUIT

SIMULATED EVOLUTION

Simulation using animation to provide a graphic illustration of the origin of biological species by natural selection. Available for IBM-PC compatible equipment. LIFE SCIENCE ASSOCIATES

FORESTRY

CACTOS

Simulation to model the changes that take place in young growth conifer stands in the mixed conifer region of Northern California. Available for IBM-PC or PS/2 compatible equipment (requires Windows). WISC-WARE

FOREST FIRE DISPATCHER

Simulation dealing with a ranger district during the forest fire season. Available for TRS-80 III equipment. DUANE BRISTOW

FOREST SAMPLE DATABASE

Two program set that allows development of a database from either variable radius plots or fixed radius plots. Available for TRS-80 I and TRS-80 III equipment. DUANE BRISTOW

GENETICS

A TUTORIAL IN RECOMBINANT DNA TECHNOLOGY

HyperCard tutorial covering recombinant DNA technology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

ADVANCED GENETICS

Tutorial/Simulation presented as a nine-part program covering dominance and recessiveness, partial dominance, lethality, mechanism of inheritance, multiple alleles, sex linkage, multi-trait inheritance, crossing over, and gene mapping. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

BEANS

Simulation to demonstrate the Hardy-Weinberg Principle of gene equilibrium as covered in a first year college course in general biology. Available for IBM-PC or PS/2 compatible equipment. WISC-WARE

BIRDBREED

Simulation providing 16 breeding groups of birds with defined phenotypes for exploring genetic principles. Available for Apple II compatible equipment. EDUTECH, INC.

CATGEN

Simulation allowing students to mate domestic cats of known genotypes. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

CATLAB (Second Edition)

Simulation in introductory genetics. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

CELLS AND GENETICS PICTURE FILE

Hi-Res diagrams of animal cell, plant cell, mitosis, meiosis, Punnett Square, sex linked traits, DNA replication, protozoa, energy reactions, and pedigree. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

DICROSS-DIHYBRID CROSSES

Simulation of various types of dihybrid crosses. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

DNAGEN-DNA/GENETIC CODE SIMULATION

Simulation of genetic code to produce protein sequences. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

DNA - THE MASTER MOLECULE

Simulation dealing with DNA structure. Programs available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

FARMER

Simulation for use in teaching basic Mendelian genetics. Available for DEC VAX equipment. THE CLEARINGHOUSE

FLYGEN

Simulation of monohybrid or dihybrid crosses with 25 varieties of Drosophila. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GENESIM

Simulations of experminents in bacterial and molecular genetics. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

GENETIC ENGINEERING

Contains two gene base sequences plus an option to enter a custom gene, comparing changes to the normal gene.

Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

GENETIC ENGINEER'S TOOLBOX

Tutorial introducing the principles and techniques of genetic engineering. Available for Apple II compatible equipment. HRM SOFTWARE

GENETICS

Tutorial/simulation in which the imaginary planet Gensim is a "microworld" in which genetic variation in a native species is determined by patterns of inheritance similar to those of humans. Available for Apple II compatible equipment. AGENCY FOR INSTRUCTIONAL TECHNOLOGY

GENETICS

Tutorial covering various crosses in plants and fruit fly populations. Program available for Apple II and TRS-80 Model III and IV equipment. J & S SOFTWARE

GENETICS

Tutorial that allows students to explore Mendel's experiments, Punnett Squares, sex linkage in fruit flies, and multiple alleles. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

GENETICS

Tutorial examines DNA molecule and progresses to applied genetics. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

GENTIC DRIFT

Tutorial-simulation focusing on random changes with time in the distribution of individuals in small populations. Program for Apple II equipment. QUEUE, INC.

HEREDITY DOG

Tutorial covering various genetic topics. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

HUMAN GENETIC DISORDERS

Simulation investigating inherited disorders. Program available for Apple II equipment. HRM SOFTWARE

INTRODUCTORY GENETICS

Three part tutorial covering a variety of topics. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

LIFE

Educational game dealing with changing distributions of individuals. Program for Apple II equipment. QUEUE, INC.

LINKOVER: Genetic Mapping

Simulation of genetic mapping experiments. Program available for Apple II equipment. CONDUIT

MACFLY

Simulation of a genetics laboratory complete with breeding fruit flies. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

mDNA

Program provides a tool for exploring different mitochondrial DNA models. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MEIOSIS

Tutorial/Simulation providing an interactive portrayal of gamete formation. Program available for Apple II and IBM-PC equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

MEIOSIS, MITOSIS, PROTEIN SYNTHESIS

Simulation demonstrating mitosis, meiosis, DNA replication, and protein synthesis. Program available for Apple II equipment. SCOTT FORESMAN & CO.

MENDELIAN GENETICS

Simulation covering dominance, partial dominance, lethality, linkage, and sex linkage. Program for Apple II equipment. QUEUE, INC.

MONOCROS-MONOHYBRID CROSSES

Simulation of various monohybrid genetic crosses. Program available for Apple II, TRS-80 models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

NATURAL SELECTION

Tutorial/Simulation dealing with genetics and evolution to populations. Available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPGEN-POPULATION GENETICS

Simulation of the effects of Hardy-Weinberg Law conditions on gene, genotype, and phenotype frequencies of a population over time. Program available for Apple II and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

MICROBIOLOGY

DILUTE-MICROBIAL DILUTION SERIES

Simulation covering design and testing of microbial dilution series to determine concentration of a bacterial solution. Program available for Apple II, TRS-80 Model III, IBM-PC, Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

INQUIRER

Database to serve as a resource to supplement information usually acquired through traditional means. Information covers fact, principles, and concepts of pathogenic bacteria, pathogenesis, and infection. Available for DEC VAX equipment. THE CLEARINGHOUSE

MICROBIOLOGY TECHNIQUES

Tutorial/Simulation covering various laboratory procedures. Available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

NEUROSCIENCE

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

AXOVACS

A simulation program that investigates the mechanisms underlying the action potential by graphically fitting the Hodgkin-Huxley equations for single or multiple channels. Available for IBM-PC compatible equipment. AXON INSTRUMENTS, INC.

COCKROACH NERVE CORD

HyperCard lab stack give an extensive description of the classic cockroach nerve preparation and covers principles of extracellular recording, recording from giant axons in the nerve cord, and stimulation of single cercal hairs. Available for Macintosh equipment (requires HyperCard 1.2.2) INTELLIMATION LIBRARY FOR THE MACINTOSH

FROG SCIATIC NERVE

HyperCard stack describes the classic frog sciatic nerve preparation. Covers nerve conduction, conduction velocity, bidirectionality, effects of temperature, and refratory periods. Available for Macintosh equipment (requires Hyper-

Card 1.2.2) INTELLIMATION LIBRARY FOR THE MACINTOSH

HUMAN BRAIN: NEURONS

Tutorial covering neuronal structure, types of neurons, electrical potentials, synaptic transmission, and neurotransmitters. Available for Apple II compatible equipment. BIOSOURCE SOFTWARE

LOLIGO ELECTRONICUS

Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. EDUCE EDUCATION TECHNOLOGIES

MEMBRANE POTENTIAL PROBLEM SOLVER

Simulation to help students grasp the complexities of cell membrane potentials. Available for IBM-PC compatible equipment. TRINITY SOFTWARE

MEMPOT

A graphical interactive program that simulates the measurement of membrane potentials in a number of excitable cells and allows the fitting of permeability parameters to the data. Available for IBM-PC compatible equipment. BARRY, DR. PETER H.

MODEL NEURON

Simulated experiments demonstrating the dynamic aspects of excitable cell behavior. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

NERVE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NEUROMUSCULAR CONCEPTS

Tutorial covering muscle action potentials, use of electromyograph, contraction, muscle action and movement disorders. Program for Apple II equipment. BIOSOURCE SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for IBM-PC compatible equipment. BIOSOFT

NEURO-SYS

Tutorial that teaches the basics of neuroanatomical techniques that are commonly used to trace nerve fibers and their interconnections. Available for IBM-PC compatible equipment. BIOSOFT

THINK TANK

Allows experimental differentiation between chemical synapses, electrical synapses and no synapses. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

NURSING

For an extensive list of educational software for nursing, consult the Directory of Educational Software for Nursing published by the Fuld Institute for Technology in Nursing Education, 28 Station Street, Athens, OH 45701 (614) 592-2511 and Software Buyers Guide published in Computers in Nursing (September/October 1990 Supplement)

PHARMACOLOGY

CARDIAC PHARMACOLOGY

Simulation of cardiac activity in response to a variety of pharmacological agents. Available for IBM-PC compatible equipment. WALKER, DR J.R.

CARDIOLAB

Simulation of cardiovascular pharmacology experiments. Available for IBM-PC compatible equipment. BIOSOFT

EFFECTS OF DRUGS ON THE UTERUS AND THE INTESTINE

Simulation of uterine activity and intestinal smooth muscle. Available for IBM-PC compatible equipment. WALKER, DR. J.R..

ILEUM

Simulates laboratory experiments investigating effects of drugs on the *in vitro* guinea pig ileum. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

MACDOPE

Simulation dealing with absorption, distribution, metabolism, and elimination of drugs. Available for IBM-PC compatible equipment. IRL PRESS

MACPHARMACOLOGY

Tutorial/review of various aspects of pharmacology. Available for Macintosh equipment. UNIVERSITY OF MINNESOTA - DULUTH

PHARMACOKINETICS

Simulation for one-compartment and two-compartment models. Available for IBM-PC compatible equipment. COOKE, DR. WILLIAM

PHARMATUTOR

Five short class exercises that include pharmacokinetic simulations, effects of agents on the cardiovascular system, and regulators of smooth muscle function and neuromuscular transmission. Available of Macintosh equipment. FUND FOR RESEARCH IN ALTERNATIVES TO ANIMAL EXPERIMENTATION

PRINCIPLES OF PHARMACOLOGY

Tutorial covering history, drug absorption and distribution, biotransformation and elimination, mechanisms of action, and drug safety and efficacy. Program for Apple II equipment. BIOSOURCE SOFTWARE

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. WALKER, DR. J.R.

PHYSIOLOGY

ABGAME

Tutorial and game providing practice in acid-base principles. Program available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

ACID-BASE BALANCE

Graphical analysis of Henderson-Hasselbalch equations. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

ACID-BASE PHYSIOLOGY SIMULATION

Simulation of acid-base disturbances based on Davenport Diagram. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

ACID-BASE SIMULATION PROGRAM

Simulation of acid-base disturbances. Values are displayed numerically and in up to five common graphical formats. Designed for use a a lecture aid and for independent study. Available for IBM-PC and PS/2 equipment (requires Windows). WISC-WARE

ARTWAVE: THE RADIAL ARTERY PRESSURE WAVEFORM

Simulation dealing with factors influencing the shape of the radial arterial pressure waveform. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

BALANCE: MYOCARDIAL OXYGEN SUPPLY AND DEMAND

Simulation of the cardiovascular system predicting myocardial oxygen supply and demand. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

BASIC HUMAN

Integrated systems model of human physiology. Program available for IBM-PC compatible equipment. RANDALL, DR. JAMES

BIOFEEDBACK

Part of 10 program package Experiments in Human Physiology. Experiments include biofeedback, conditioning, and perception measurements. Program available for Apple II equipment. HRM SOFTWARE

BIOFEEDBACK MICROLAB

Package includes a pulse rate sensor that measures EMG, a thermistor probe to measure skin temperature, and an interface circuit that enables student to connect the sensors to the computer. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

CALIBRATION

Part of 10 program package Experiments in Human Physiology. Temperature and timing functions are calibrated against standards. Program available for Apple II equipment. HRM SOFTWARE

CAPEXCH

Simulation dealing with exchange at the capillary level. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

CARDIAC MUSCLE MECHANICS

Simulation of heart muscle behavior in response to changes in length, load, and contractility. Available for IBM-PC compatible equipment. QUEUE, INC.

CARDIOCOMP

ECG/EMG data acquisition and analysis system. Available for IBM-PC compatible equipment. INTELITOOL INC.

CARDIOVASCULAR FITNESS LAB

Provides students with everything they need in order to use the microcomputer to monitor cardiovascular activity. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

CARDIOVASCULAR FUNCTION LABORATORY / PHYSIOLOGY LABORATORY TUTOR

Programs developed to provide problem-based learning in cardiovascular physiology. Available for IBM-PC compatible and Macintosh equipment. FROM THE HEART SOFTWARE

CARDIOVASCULAR INTERACTIONS

Cardiovascular Physiology simulation. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

CARDIOVASCULAR PHYSIOLOGY PART I: PRESURE/FLOW RELATIONS

Tutorial dealing with a variety of calculations in the area of hemostatics/hemodynamics. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CARDIOVASCULAR PHYSIOLOGY PART II: REFLEX

Tutorial dealing with carotid sinus regulation of blood pressure, and reflex responses in hemorrhage and exercise. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CIRCSIM: A TEACHING EXERCISE ON BLOOD PRESSURE REGULATION

Simulated experiment based on a model of the baroreceptor reflex loop. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CIRCSYST

Simulation of hemodynamics. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

COMMON THEMES IN PHYSIOLOGY – CONSERVATION OF MASS

Simulations/problems applying conservation of mass principles to physiological situations. Included are indicator dilution experiments and mass balance experiments. Available for IBM-PC compatible equipment. NRCLSE

COMMON THEMES IN PHYSIOLOGY – OSMOTIC PRESSURE RELATIONSHIPS

Tutorial format using simulated experiments covering determinants of osmotic pressure, cell reactions to osmotic environments, and fluid movement at the capillary. Available for IBM-PC compatible equipment. NRCLSE

CONCEPTS IN THERMOGRAPHY

Tutorial covering basic DC concepts, peripheral vascular physiology, detecting skin temperature, amplifiers, and processing DC signals. Program for Apple II equipment. BIOSOURCE SOFTWARE

CRAB ION BALANCE

HyperCard stack describing the effects of blood sodium levels in crabs bathed in water with different salinities. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

DIGESTION

Tutorial covering digestion in simple organisms and humans. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

EFFECT OF SIZE ON MOUSE METABOLISM

HyperCard stack describing the effects of mouse size on the metabolic rate. With the use of simple metabolic chambers, experiments are performed on mice of different sizes. Available for Macintosh equipment (requires HyperCard1.2.2). INTELLEMATION LIBRARY FOR THE MACINTOSH

ENDOLAB

An endocrine physiology computer laboratory designed to provide some experience with the effects of a number of hormones as well as practice in problem-solving in endocrinology. Available for IBM-PC compatible equipment. DIETZ, DR. JOHN R.

ENDOCRINE SYSTEM

Tutorial covering hormones, effects and problems. Program available for

Apple II and TRS-80 Model III equipment. J & S SOFTWARE

EXCRETION

Tutorial reviewing metabolic wastes, waste removal, and kidney function. Program available for Apple II equipment. J & S SOFTWARE

EXERCISE EXPERIMENTS

Part of 10 program package Experiments in Human Physiology. The effect of exercise and physical condition on heart rate, breathing rate, and skin temperature is investigated. Program available for Apple II equipment. HRM SOFTWARE

EXERCISE PHYSIOLOGY

Simulation of some of the important physiological measurements that can be made to assess cardio-respiratory performance of "fitness" in the laboratory. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

FLEXICOMP

Data acquisition and analysis system for studying the reflex arc. Available for Apple II and IBM-PC compatible equipment. INTELITOOL, INC.

FROG GASTROCNEMIOUS MUSCLE

HyperCard stack describing the classic frog gastrocnemius muscle preparation. Covers the muscle twitch, stimulus-response relationships, work fone, summation, and tetanus. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

FROG HEART

Simulation of experiments that can be performed on the *in situ* frog heart. Available for IBM-PC compatible and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

FROG HEART

HyperCard stack describing the classic frog heart preparation. Covers heart contraction, temperature effects, adrenaline, and acetylcholine effects, and the refractory period of the ventricle. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

FROG SKIN - MEMBRANE TRANSPORT

Simulation of experiments that can be performed on the frog skin preparation to teach the principles of the epithelial transport of ions. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

GAS DIFFUSION IN THE LUNG

Simulation of oxygen and CO2 transfer between alveolar air and blood. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

GASP: A TEACHING EXERCISE ON THE CHEMICAL CONTROL OF VENTILATION

Simulated experiment based on a nodel of the chemical control of ventilation (MACPUF). Available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

GLOMERULAR FILTRATION, CONCENTRATION-DILUTION, Tm

Package of three renal physiology teaching programs. Available for IBM-PC compatible equipment. DIETZ, DR. JOHN R.

GUINEA PIG ILEUM

Simulation of the isolated, transmurally stimulated guinea pig ileum preparation to investigate the effects of drugs on neurotransmitter release in the enteric nervous system. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

HEART RATE

Part of 10 program package Experiments in Human Physiology. Light and light sensor for measuring and recording heart rate. Program available for Apple II equipment. HRM SOFTWARE

HOMEOSTASIS-THERMOREGULATION

Part of 10 program package Experiments in Human Physiology. Students investigate the body's ability to maintain a constant internal temperature by subjecting a volunteer to mild temperature excursion while recording and displaying skin and body temperature. Program available for Apple II equipment. HRM SOFTWARE

HUMAN BODY-STRUCTURE AND FUNCTION

Simulation covering joint movement, movement of food through digestive system, and enzyme activity. Program available for Apple II equipment. SCOTT, FORESMAN & COMPANY

HUMAN CIRCULATORY SYSTEM

High resolution pictorial simulation. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

HUMAN ELECTROCARDIOGRAM

HyperCard stack describes the classic human ECG (response, artifacts, heart sounds, exercise effects) and finger pulse (dicrotic notch, exercise effects, temperature effects). Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

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Australia

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Leeds LS1 3HE United Kingdom

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University of Minnesota – Duluth
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Duluth, MN 55812-2487
(218) 726-8512

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University of Texas Medical Branch
Galveston, TX 77550
(409) 761-2966

Williams & Wilkins
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Baltimore, MD 21202
(800) 638-0672

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

KEEPING ABREAST OF THE LITERATURE 41
WHERE'S THE SOFTWARE? – PART 3 43

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KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WHERE'S THE SOFTWARE? – PART 3

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on pages 46 and 47.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

PHYSIOLOGY (CONTINUED)

HUMAN LUNG

HyperCard stack allowing students to record breathing movements and the corresponding electrocardiogram. The experiments include the effect of gravity on lung capacity and of rebreathing on breathing. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

HUMAN SEXUALITY

700 questions test item bank dealing with the anatomy/physiology of human reproductive system. Available for DEC VAX equipment. THE CLEARINGHOUSE

LOLIGO ELECTRONICUS

Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. EDUCE EDUCATION TECHNOLOGIES

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

MACMAN

Simulation of circulatory system. Available for IBM-PC compatible equipment. IRL PRESS

MACPEE

Simulation of interactions of renal physiology. Available for and IBM-PC compatible equipment. IRL PRESS

MACPUF

Simulation of cardiopulmonary physiology. Available for IBM-PC compatible equipment. IRL PRESS

MECHANICAL PROPERTIES OF ACTIVE MUSCLE

Set of six programs concerned with skeletal muscle contraction. Available for IBM-PC compatible equipment. QUEUE, INC; TRINITY SOFTWARE

MOUSE THYROID GLAND

HyperCard stack describes the effects of reversal thyroid destruction on growth rate and cold temperature on the metabolic rate. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

MUSCLE MECHANICS: A COMPUTER-SIMULATED EXPERIMENT

Simulated experiment that permits the user to determine either the length-tension or the force-velocity relationship of a skeletal muscle. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

MUSCLE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve-gastrocnemius muscle to illustrate some of the physiological properties of skeletal muscle. Available for IBM-PC compatible and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NERVE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NERVOUS SYSTEM

Tutorial covering nerves, reflexes, and chemical transfer of impulses. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. BIOSOFT

O_2/CO_2 TRANSPORT MODEL

Simulation for studying oxygen transport from the lungs to the tissues. Available for Apple II and IBM-PC compatible equipment. GAAR, DR KERMIT

PHYSIOLOGICAL DATA SIMULATION

25 simulations covering aspects of physiology. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

PHYSIOLOGICAL SIMULATION PROGRAM

The basic purpose of this program is to provide interactive software that can be used in a variety of physiological simulations applicable for biomedical teaching and research. Available for IBM-PC or PS/2 equipment (requires Windows 2.03). WISC-WARE

PROBLEMS IN FLUID COMPARTMENT RE-DISTRIBUTION

Tutorial covering solution of simple problems of fluid compartment changes in the face of perturbations. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

PSIMPLE

Twenty-five problem sets, each containing between 4 and 15 problems.

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Areas covered include cardiovascular, respiratory, and renal physiology. Available for Macintosh equipment. MINES, DR ALLAN H.

PSYCHOLOGICAL STRESS-LIE DETECTOR

Part of 10 program package Experiments in Human Physiology. The physiological response to the stress of a frustrating and abusive quiz is measured. Program available for Apple II equipment. HRM SOFTWARE

PULMONARY MECHANICS

Tutorial and simulation dealing with pulmonary mechanics. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. WALKER, DR J. R.

PERMEABILITY

Simulation of osmotic phenomena in cells. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

PHYSIOGRIP

Data acquisition and analysis system for the muscle physiology lab. Available for Apple II and IBM-PC compitble equipment. INTELITOOL, INC.

RENAL GLOMERULAR DYNAMICS

Simulation of human glomerulus and factors that affect glomerular filtration rate. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

RESPIRATION RATE

Part of 10 program package Experiments in Human Physiology. A napping subject is monitored for heart and breathing rate. Results are compared to the data acquired when the subject is awake. Program available for Apple II equipment. HRM SOFTWARE

RESPONSE-TIME

Part of 10 program package Experiments in Human Physiology. Users measure finger reaction times with a bright light stimulus (sensor included). Program available for Apple II equipment. HRM SOFTWARE

RESPONSE-TIME INVESTIGATIONS

Part of a 10 program package Experiments in Human Physiology. The effects on reaction times of stimulus type and response location are studied. Program available for Apple II equipment. HRM SOFTWARE

RESPSYST, GASEXCH

Simulations dealing with pulmonary gas exchange. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

SIMULATIONS IN PHYSIOLOGY - THE RESPIRATORY SYSTEM

Series of 12 simulations dealing with respiratory mechanics, gas exchange, chemoregulation and acid-base balance. Program available for Apple II, IBM-PC compatible, and Macintosh equipment. NRCLSE

SKELETAL MUSCLE ANATOMY/ PHYSIOLOGY

Tutorial covering three muscle categories, skeletal muscle microstructure, sliding filament theory, motor units, and lever systems. Program for Apple II equipment. BIOSOURCE SOFTWARE

SKELETAL MUSCLE CONTRACTIONS

Tutorial/Simulation of muscle mechanics. Available for IBM-PC compatible equipment. SIEGMAN, DR. MARION J.

SKILLS IN ELECTROMYOGRAPHY

Tutorial covering skin preparation, reducing EMG artifact, testing a myograph's operation, electrode location, and preventing shock hazards. Program for Apple II equipment. BIOSOURCE SOFTWARE

SKIN TEMPERATURE

Part of a 10 program package Experiments in Human Physiology. Temperature probe (included) senses body and skin temperatures. Program available for Apple II equipment. HRM SOFTWARE

SPIROCOMP

Data acquisition and analysis system for measuring lung volumes and capacities. Available for Apple II and IBM-PC compatible equipment. INTELITOOL, INC.

THE AUTONOMIC SYSTEM

Tutorial on neurophysiology, the parasympathetic system and the sympathetic system. Available for Macintosh equipment. IRVINE INTERACTIVE INC.

THE CARDIAC CYCLE

HyperCard stack providing students with three animations for viewing the cardiac cycle: a four-chamber echocardiographic sequence, a Wiggers' plot of physiologicaly variables, and a pressure-volume diagram of the left ventricle. Available for Macintosh equipoment. GOERKE, DR. JON

THE CARDIAC VECTOR

HyperCard stack examining how hyocardial electrical events generate the frontal vectorcardiogram and the standard limb leads of the electrocardiogram. Available for Macintosh equipment. GOERKE, DR. JON

THE CARDIOVASCULAR SYSTEM

Tutorial on hemodynamics, peripheral circulation, the heart, and integration. Available for Macintosh equipment. IRVINE INTERACTIVE INC

THE ELECTROCARDIOGRAM

Interactive, menu-driven program to teach the fundamentals of the electrocardiogram. Available for IBM-PC compatible and BBC B/Master equipment. SHEFFIELD BIOSCIENCE PROGRAMS

THE EINTHOVEN TRIANGLE

HyperCard stack that allows students to explore how changes in the direction and magnitude of the cardiac net dipole vector affect voltages in the standard electrocardiographic leads. Available for Macintosh equipment. GOERKE, DR. JON

THE ENGINE OF LIFE

An animated tutorial about the human heart. Available for IBM-PC compatible equipment. PI1 ENTERPRISES

THE LANGENDORFF HEART

Simulated experiments that can be performed on the isolated perfused mammalian heart (Langendorff preparation). Available for IBM-PC compatible equipment. SHEFFIELD BIOLSCIENCE PROGRAMS

TITRATION

Graphical analysis of buffers. Available for Apple II compatible and Macintosh equipment.
HEMPLING, DR. HAROLD G.

VENTROL

Tutorial and simulation dealing the the regulation of breathing. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

WATER AND ION MOVEMENT ACROSS FROG SKIN

HyperCard stack describes the effects of ouabain and antidiuretic hormone on the movement of sodium and water across frog skin. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

POPULATION DYNAMICS

BALANCE-PREDATOR-PREY SIMULATION

Simulation of the effects of food supply, carrying capacity, environmental conditions, and external pressures or predator/prey relationships. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

COEXIST:Population Dynamics

Simulation of the growth of two populations either independently or in competition for the same limited resources. Program available for Apple II equipment. CONDUIT

COMMUNITY DYNAMICS

Tutorial/simulation dealing with interaction of predator and prey systems. Available for Apple //e equipment.
EDUCATION MATERIALS & EQUIPMENT CO.

ISLAND BIOGEOGRAPHY

Three simulations of island communities dealing with the relationship between island area and number of species, colonization of a new island, and island immigration and extinction. Program available for Apple II equipment.
CONDUIT

LIMITS

Simulation of the effects of growth on world population, pollution, food supply, industrial output, and natural resources. Program available for Apple II, PET/CBM and TRS-80 Model III equipment. COMPUWARE

MARK & RECAPTURE

Simulation of mark and recapture experiments to explore three models for estimating population sizes. Program available for Apple II equipment.
CONDUIT

POP

Simulation of three growth models (exponential, logistical, and logistical with low density). Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

POPGRO-POPULATION GROWTH SIMULATION

Simulation of unlimited growth (J-curve), limited growth (S-curve) and limited growth with response lag time (S-curve with oscillations) models of population growth. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

POPULATE

Designed as a supplement to courses for first-year biology science majors. It is intended as a preview of material to be presented in lecture. Available for DEC VAX equipment. THE CLEARINGHOUSE

POPULATION CONCEPTS

Simulation dealing with factors influencing population growth. Available for Apple //e, TRS-804, and TRS-80 III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPULATION FLUCTUATIONS

Tutorial covering factors influencing population growth. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPULATION GROWTH

Simulation dealing with exponential and density-dependent gowth. Program for Apple II equipment. QUEUE, INC.

POPULATION GROWTH

Simulation of population growth. The package compares and contrasts the geometric or exponential growth model with the logistic or Verhulst-Pearl growth model. Program available for Apple II equipment. CONDUIT

POPULATON SIZES

Simulation dealing with a dynamic population. Program for Apple II equipment. QUEUE, INC.

PREDATION

Simulation of predator-prey interactions. Program available for Apple II equipment. CONDUIT

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

CLSE 1991 COLLEAGUE DIRECTORY – PART 1 49

CLSE 1991 COLLEAGUE DIRECTORY – PART 1

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is updated from the 1990 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 7 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 2 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 7 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

COMMENTS ON COURSEWARE 57
Charles L. Ralph

CLSE 1991 COLLEAGUE DIRECTORY – PART 2 61

COMMENTS ON COURSEWARE

Charles L. Ralph

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For nearly 6 years, I have been much involved with the use and generation of instructional software, i.e., courseware, as an adjunct to the two freshman biology courses I teach annually at Colorado State University. Beginning in 1985, I used Apple IIe computers with monochrome monitors to run a few proprietary programs as a component of the 2-hour, weekly laboratory in one of my freshman classes. By selecting as best I could from the limited and uneven proprietary software then available, I assembled enough programs to allow the students to spend, on average over the course of a semester, about half of their time at the bench doing traditional laboratory exercises and half with the computers (two students per computer, in a facility with 10 computers that adjoined the hands-on laboratory). This design was extended to my other semester course the next year. By the end of 1986, I was using a total of about 40 programs in the two courses. In 1987 I replaced the Apple IIes with Apple IIgs computers with color monitors and used them for 2 years in the mixed, traditional-computer laboratory design.

This *ad hoc* assemblage of programs served rather well to enrich, diversity, and enhance the quality of the laboratory experience for my students.[1] Repeated evaluations over several semesters showed a strongly positive student approval of the mixed laboratory. However, certain aspects of the courseware left me dissatisfied. For example, most of the color programs ran well on the RGB monitors of the IIgs computers, but the text of monochrome programs was usually very badly presented. To switch back and forth between RGB and monochrome monitors was a nuisance. The operational procedures for interacting with the programs varied widely, so it was necessary to provide the student with

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instructions on how to operate each program, which wasted valuable time and could be frustrating. The programs were uneven in academic level and running time. While there were several programs available on genetics and cell division, for example, most other areas of biology were poorly represented or not represented at all.

The upshot of my dissatisfaction with other people's courseware was that I decided to create my own – a comprehensive, uniform, easy-to-operate set of programs. What seemed at first like an impossible task became feasible for two reasons: (1) the appearance of the Macintosh computer, with it crisp, graphic user interface, and (2) on-screen, iconographic, authoring programs. The history of the creation of a set of Basic Biology programs, 52 in number, over the course of 3 years has been related elsewhere, [2,3] and I will not elaborate here on this endeavor.

The above information is given to provide evidence that the comments which follow have been conceived in the course of grappling with extant courseware while pondering what courseware could or should be for the instructional niche in which I toil. Although my comments are based on experience with courseware for biology, I trust most of them will have some relevance to courseware in other disciplines and to levels other than that of the university freshman. In recording my opinions about courseware, I do not claim to be an authority, for I am regularly humbled by discovering that what I thought was valid turns out to be questionable. Also, my remarks are not meant to be a critique of the work of others and the promotion of my own. A range of opinions about the design and use of courseware is a healthy thing. I have had the advantage of learning much from others and have blended their creations into my own. Along the way I have formed some tentative opinions which may be useful to share with others who are considering venturing into use of courseware in their teaching, either by adopting the products of others or by creating their own.

TUTORIALS OR SIMULATIONS?

It is a fairly widely held opinion among teaching faculty in the sciences that students should be exposed to the simulations of processes and events in a fairly rigorous, quantitative way. My experience is that freshman biology students rarely have enthusiasm for interacting with a simulation any longer than minimally necessary. I have been often exasperated to watch my students take the shortest route possible through a simulation and shun the many informative alternatives and variants that could be tested. On the other hand, they will work tediously through tutorials, taking notes, and often repeating certain sections that may have been comparatively difficult for them on first pass.

My position is that while simulations are splendid things to do on computers, they generally are not an efficient use of computers and time in my classes. Consequently, the programs I produced have relatively minor components that are purely simulations. With more advanced, motivated, or seasoned students simulations are a better investment of time and effort.

Tutorials can and should incorporate opportunities for interactions with the student user. High-end authoring systems, such as Authorware Professional, allow the construction of a variety of interactions, including moving items on the screen, typing answers to which coaching and feedback are evoked, and graphic plotting of values derived from experimental simulations. Computers have the great virtue of affording much more interaction than other media.

BRANCHING OR LINEAR PROGRAMS?

With multimedia and HyperCard being the current enthusiasms of a major segment of the education community, there is a great deal of promotion of non-linear, open-ended courseware. Programs with buttons and choices galore are proliferating mightily. Indeed, it is exciting to be able to wander with a newly-available freedom to mine the lode of informational nuggets in such programs. To access text, graphics, and sounds in a self-directed pathway can be an exhilarating experience.

However, I have misgivings about all the hyperbole and enthusiasm for many of the products of the branching genre. They are quite useful for and effective with advanced or sophisticated students but of doubtful application to the naive or beginning student. I find that freshman biology students are quite insecure with an open-ended program. They worry about when they should be finished, or whether they have seen everything they should have. It is somewhat like giving the student a fine encyclopedia and telling them to feast on a self-selected set of topics. Most cannot handle such a golden opportunity. My students deal much better with the linear program. Such a design embodies a "story" – it has a beginning and end. The information is structured in a usually logical sequence, with inter-dependencies for comprehension. At least the students know that they have seen all of the program and made the same passage as their colleagues. This is not all bad for the typically insecure, beginning student.

WORDS AND PICTURES

Text on the highest-quality computer monitor is still inferior in appearance to well-printed type on paper. Words generated from videodiscs may be annoying as they can be blurred and may often jiggle. Text on computer screens should be concise, necessary, appropriately and attractively positioned, of a crisp and bold font, and conservatively employed. Furthermore, to present textual information on a computer routine that could be given to a student printed on paper is a sad waste of an expensive and special technological device.

Graphics obviously are the forte of the computer screen. Complex diagrams can

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be incrementally constructed or progressively dissected to bring clarity of explanation. Highlighting, flashing arrows, and episodic labeling and commentary can explain drawings and diagrams in a way that is superior to the static graphics of textbooks. Biology is particularly dependent on illustrations to provide graphic metaphors of things we cannot see but can imaging, or of things that we can see and must understand as structures before we comprehend their functions. So, the comparatively liberal use of graphics and constrained use of text appears to me to be one of the yardsticks by which to measure courseware.

ANIMATION

Along with the graphics capability stands animation as another great virtue of the computer as a superior teaching tool. To have dynamic graphics illustrating complex events over time is a wonderful window on understanding. Animations can be intriguing in ways that never can be achieved by static illustrations. It is like movies versus still pictures. Each has their uses, but when movement is entailed there must be animation to give a proper feel for the evolving event.

Animation needs to be used with restraint, however. Motion for the sake of cuteness or pizazz often palls. I have seen several animations which, when first viewed, were amusing but, after a few repetitions, became an annoyance to endure. I have noted that the new student interns in my summer authoring program at first incorporate a lot of zooms and fades in their programs, but the novelty soon wears off, and those features are used less and less. Just because some things can be done with computers does not mean they should be.

SOUND

Like animation, sound adds a nice dimension to certain aspects of some programs. It can be used to alert the student to important items or an appropriate sound can reinforce a visual message. Digitized natural sounds – the song of a bird or whale while the animal is being graphically represented – can be a wonderful addition to programs, for example.

However, also like animation, sound can be over-used. To my surprise, I have found that given the possibility to do so, most students will turn the sound on their computer off after the novelty of hearing the computer produce sound has lost its impact. We now use sound more judiciously than we did formerly. Sound is a big memory hog, so the cost and benefit of incorporating sounds should be carefully considered. Potential purchasers of programs and software reviewers are more enthusiastic about sounds in programs than seasoned student users.

COLOR

There is no question that programs in color are a lot more eye appealing than monochrome ones. Furthermore, color can convey information about the real appearance of objects, enhance detail, and make graphic objects more readily interpretable. Thus, color is highly desirable in courseware. But there are problems with color. First, on Macintosh equipment, it is memory hungry. Our monochrome programs already press the limits of the 800K floppy disk. Most will not fit on that medium in color versions; a format with more space, and therefore of greater cost, is needed for robust programs in color. Second, to see color, obviously one must have a color monitor. At CSU we face the prospect of abandoning our 20 Macintosh Plus computers, which each cost about $1,000, and replacing them with color computers with CD-ROM drives at perhaps minimally $3,000 per computer. Thus, the added cost of color is a significant increment.

OPERATION

Much of my dissatisfaction with using other folks' courseware was that virtually no two programs are operationally the same. Most of them required some form of documentation to inform the user about what to do to get into the program and make it work. That is time consuming and can be very frustrating. When we began the creation of the Basic Biology series, it was a given that all would have the same operational features and they would be so simple to run that no documentation would be required. Thanks to the graphic user interface of the Macintosh and its widespread familiarity in the educational community, this has become a reality. I have experienced disbelief among some of my peers that documentation is not needed (textbook publishers and users of computers other than Macintoshes are among the most recalcitrant). However, I have yet to have anyone who has purchased our programs ask about documentation. All the user needs to know is how to click, double click, and click and drag with a mouse. On-screen directions provide all the guidance a user requires.

We have consciously attempted to place buttons on the screen in the same positions. Also, where student interaction is required, the response called for is stated in the same font and style. Additionally, words that are in the pulldown glossary (a unique set of words for each program) are indicated in the program's text by being in boldface type. In other words, consistency and simplicity are the goals, for I want the computer to not be a significant element in the student's learning environment. "Driving" the computer should quickly become as unconsciously easy as any other often repeated routine.

VIABILITY

As we all learn, first impressions do not always last. We who teach have sometimes adopted textbooks that looked good on first encounter but with studied use have turned out to be quite unsatisfactory. Software can be even more of a shot in the dark, for there is comparatively little of it for choosing and comparing and few people have had much experience in selecting it. What at first looks like a peach of a program may, in the hands of students, turn out to be a disappointment. I suspect that some of the panache that sells a program may not be of much use to the student seeking enlightenment. The programs that endure are not necessarily the ones that get rave reviews from faculty colleagues whose evaluations may be based on criteria other than that of the pragmatic student. A flashy program here and there does not make a sustaining intellectual meal.

SCREEN DESIGN

Consistency of placement of objects, standardization of fonts and text styles, and uniformity of appearance are hallmarks of a good courseware series. All these elements conveniently will convey meaning if consistency is practiced. In developing our programs, we spent a lot of effort on deciding how a screen looks, in terms of symmetry and balance, use of space, and esthetic appeal. Just like any source of information, it is more compelling and more effective if it has eye appeal. Credibility is conveyed by good appearance.

I cannot claim that our programs are paragons of good screen design, for one is regularly pressed to get all the essential information in a very constraining rectangle (i.e., the consistently too small computer screen). We strive to be as succinct in words as possible, but frequently settle for an all too cluttered screen. Even the limits imposed by the floppy disk causes us to sometimes make fewer screens, and thus load more on too few of them.

EPILOGUE

There is not yet a critical mass of courseware for any discipline known to me. There are just bits and pieces here and there. The choices are still poor for anyone shopping for courseware. I suspect a lot of potential users are looking at the possibility of using courseware and then rejecting what is available, for they do not quite know what they are looking for or they do not like what they find. The latter are waiting for something "better." Sadly, there is not likely to be much of anything better very soon if more educators do not start using what is in the market. The incentives for producing better or more numerous products are very few in the education sector, both from the standpoint of scholarly rewards and financial return. Educators need to better articulate what it is they would like to see in courseware and to make a go at using the best of the lot now on hand in their instructional repertoire.

How we encourage the development of better courseware is something to be concurrently addressed. Vogeli[4] has called for a scientific basis for software development to replace the customary "seat-of-the-pants" approach that has haphazardly produced the present crop of courseware. He asserts that without an appropriate learning-theoretic basis for software development the computer may be relegated to the crowded dust bin of failed educational fads.

A standardized storage medium for delivery of robust courseware is badly needed. The capacity of the floppy disk is too restricted. A combination of floppy disk for text and videodisc for pictures is neither compact nor convenient. All images should be on one screen that combines the best features of computers and videos, an arrangement that is currently rather expensive. CD-ROMs are promising storage devices except for fast-frame movies. Perhaps "flopticals" which combine magnetic and optical storage are the current best prospect, provided they can be read simultaneously. File compression, such as that which will be afforded by Apple's forthcoming QuickTime software, promises to alleviate much of the storage space problem. Whatever the technologically optimum solution, it is needed now to facilitate the evolution of quality courseware, and it must be widely affordable. Until the delivery platform is adequate and capacious, we are going to continue to be looking at mostly primitive and fairly lifeless courseware.

This article was based on a presentation at the Technology in Education Conference in Snowmass, Colorado, June 14, 1991.

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CLSE 1991 COLLEAGUE DIRECTORY – PART 2

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1991 directory published last month. It is updated from the 1990 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 7 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 2 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 7 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 65

CLSE 1991 COLLEAGUE DIRECTORY – PART 3 66

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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CLSE 1991 COLLEAGUE DIRECTORY - PART 3

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1991 directory published last month. It is updated from the 1990 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 7 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 4 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 7 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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or let us know via BITNET. NRCLSE's BITNET address is MODELL@UWALOCKE.

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

CLSE WILL CHANGE FORMAT IN 1992 73

CLSE 1991 COLLEAGUE DIRECTORY – PART 4 74

NRCLSE SOFTWARE EVALUATION SUBMISSION FORM 76

CLSE WILL CHANGE FORMAT IN 1992

Harold I. Modell
National Resource for Computers in Life Science Education, Seattle, Washington

Since its inception in 1984, CLSE has strived to serve as a resource for life science educators interested in using computers in their teaching efforts. In the early years of the publication, considerable space was devoted to articles intended to highlight relevant issues, serve as tutorials for colleagues beginning their endeavors, and provide a means of sharing the experiences of colleagues who had used computers in their teaching efforts. However, as the body of available software and resources grew and the number of colleagues willing to share their efforts grew, more pages of the restricted 8-page newsletter format became dedicated to the annual or quarterly features of CLSE.

NRCLSE wishes to provide the kind of articles that was the rule rather than the exception in the early volumes of CLSE while still providing the annual and quarterly resource features. This will entail adding more pages to CLSE, which tends to increase costs, especially if the newsletter is published on a monthly basis. By

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publishing the newsletter quarterly, however, the added cost of production can be offset by reducing the frequency of production. Hence, to restore the original intent of CLSE and to allow publication of the regular informational features at the *same cost to subscribers*, we will change our publication format in 1992. Volume 9 will be published as a quarterly published in March, June, September, and December. Keeping Abreast of the Literature will be printed in each issue. One issue will be devoted primarily to "Where's the Software?", and one issue will be devoted primarily to the CLSE Colleague Directory. The remaining issues will contain articles and features (eg, Where are the Videodiscs?) devoted to helping faculty make the best use of computer technology in their teaching efforts. The new format will undoubtedly lead to an increase in the total number of pages printed per year, but the subscription rate will remain at this year's levels (see page 80). NRCLSE hopes that by making this change, we can better serve the life science community.

To best serve the community, we need to know your needs. Please let us know what kinds of articles you would like to see in CLSE. Send comments to Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

CLSE 1991 COLLEAGUE DIRECTORY – PART 4

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1991 directory published last month. It is updated from the 1990 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 7 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 7 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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Harold I. Modell, Ph.D.

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MENU

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2) Cell reactions to osmotic environments
3) Fluid movement at the capillary
4) Quit

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CONTENTS

ADAPTING MS-DOS QUICKBASIC PROGRAMS FOR THE MACINTOSH 81
Harold I. Modell

ADAPTING MS-DOS QUICKBASIC PROGRAMS FOR THE MACINTOSH

Harold I. Modell
National Resource for Computers in Life Science Education, Seattle, Washington

In the early 1970s, we developed a set of simulations in respiratory physiology to enable students to test their concepts in a simulated laboratory environment.[5] The programs were developed on a minicomputer, and the output was presented as an 80-column data table printed on the computer terminal. To insure maximum versatility, great care was taken to write the programs in a lowest common denominator BASIC. In this way, anyone whose computer system supported a version of BASIC that provided for string variables could have access to the programs. With the introduction of the microcomputer came the possibility of graphic or pictorial outputs, and the respiratory programs were rewritten to include pictorial conceptual aids.[6] However, in order to provide the same degree of equipment flexibility as the original set of programs, it was necessary to write three versions of each program, one for use with the Apple II family, one for use with MS-DOS machines, and one for use with Macintosh equipment, because a "lowest common denominator" language that supported graphics on microcomputers did not exist.

In 1990, we began developing a new set of programs focused on common themes in physiology.[3,4] We chose Microsoft's QuickBASIC as our programming language because the language was available for both MS-DOS and Macintosh equipment, and we felt that a minimum

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Table 1. Keywords used only by QuickBASIC for the MS-DOS environment. (Adapted from Waite et al.[7])

ACCESS
BLOAD
BSAVE
CALL ABSOLUTE
CALL INT86OLD
CALL INTERRUPT
CALLS
COLOR
COMMAND$
COMMON SHARED
COM ON/OFF/STOP
CONST
CVDMBF
CVSMBF
DECLARE
DEF SEG
DO...LOOP
DRAW
ENVIRON
ENVIRON$
ERDEV
FILEATTR
FREFILE
FUNCTION
INP
IOCTL
IOCTL$
KEY
LCASE$
LOCK
LTRIM$
MKDIR
MKDMBF$
MKSMBF$
ON COM GOSUB
ON KEY(n) GOSUB
ON UEVENT GOSUB
ON PEN GOSUB
ON PLAY GOSUB
ON STRIG GOSUB
OPEN COM
OUT
PAINT
PALETTE, PALETTE USING
PCOPY
PEN
PEN ON/OFF/STOP
PLAY
PMAP
REDIM
RMDIR
RTRIM$
SCREEN
SEEK
SETMEM
SHELL
SLEEP
STICK
STRIG
TYPE...END TYPE
UNLOCK
VARSEG
VARPTR$
VIEW
VIEW PRINT
WAIT

amount of machine specific programming would have to be done to convert the software from one platform to the other. The purpose of this communication is to share what was learned during that conversion process.

PROGRAM OVERVIEW

The program was originally written using QuickBASIC Version 4.5 for IBM personal computers and compatibles. It was designed as a tutorial that used pictorial simulations to help students understand osmosis and osmotic relationships within the body.[4] The program contained 3 sections focusing on different aspects of these relationships. It included text presentation, interaction with the student through prompted inputs, screens that combined text with graphics, and some animation. Consistent with the lowest common denominator philosophy, and, because the program was intended for use in a classroom as well as independent study setting, the graphics were restricted to the CGA mode, and all text screens were limited to a 40 column width.

The program design included use of procedures in the form of subroutines using the SUB...END SUB structure, standard graphics statements, standard text input/output statements, IF...THEN...ELSE comparisons, and floating-point, string, and integer variable types. Use of programming features that are unique to the MS-DOS environment (eg, use of FUNCTION...END FUNCTION construction for procedures, see Table 1) were avoided whenever possible.

To transfer the program to the Macintosh, the listing was saved as a text file, an option in the QuickBASIC v4.5 Save As dialog box, and ported to the Macintosh through a serial interface using communication software. The program was then saved as a text file on the Macintosh for opening by QuickBASIC Version 1.0.

CHOOSING A VERSION OF QuickBASIC FOR THE MACINTOSH

Two versions of QuickBASIC are supplied on the Macintosh QuickBASIC distribution disk. One is designated as the decimal version and the other as the binary version. The decimal version, intended for business and financial applications, does not round off double-precision numbers. The binary version, intended for scientific and engineering applications, adheres to the IEEE standard for handling arithmetic operations. The arithmetic operations are faster in the

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binary version, and this was the version of choice for our application.

Table 2. Keywords used only by QuickBASIC for the Macintosh environment. (Adapted from Waite et al.[7])

BREAK ON/OFF/STOP
BUTTON
CONT
CVDBCD
CVSBCD
DIALOG
DIALOG ON/OFF/STOP
EDIT$
EDIT FIELD
FILES$
LCOPY
LIBRARY
LIBRARY CLOSE
LOAD
MENU
MENU ON/OFF/STOP
MENU RESET
MERGE
MKDBCD$
MKSBCD$
MOUSE
MOUSE ON/OFF/STOP
ON BREAK GOSUB
ON DIALOG GOSUB
ON MENU GOSUB
ON MOUSE GOSUB
PEEKL
PEEKW
PICTURE
PICTURE ON/OFF
POKEL
POKEW
PTAB
SCROLL
SOUND RESUME
SOUND WAIT
SYSTEM
TOOLBOX
WAVE
WINDOW

GETTING THE PROGRAM TO RUN

The Macintosh QuickBASIC program was able to open the text file of the MS-DOS listing with no problem. However, before attempting to run the program, several modifications had to be made.

Subroutines

QuickBASIC v4.5 requires that all procedures using the SUB...END SUB format be specified in DECLARE statements, usually placed at the beginning of the program. For example, the statement

```
DECLARE SUB celldata (m!,m9!,data$())
```

tells the system that celldata is a subroutine and that the variables, m, m9, and data$ are to be passed to or from the subroutine. Furthermore, m and m9 are single-precision floating point variables and data$ is a string variable array. Macintosh QuickBASIC doesn't recognize this statement, and, therefore, the DECLARE statements had to be deleted from the program.

The subroutine definition statement also had to be modified. In QuickBASIC v4.5, the statement that begins the subroutine definition takes the following form.

```
SUB celldata (m, m9, data$())
```

In the Macintosh QuickBASIC environment, all subroutines must be static (i.e., local variables are preserved between subroutine calls). Hence, the keyword STATIC had to be added to all SUB statements:

```
SUB celldata(m, m9,data$()) STATIC
```

The STATIC keyword is optional for compiled programs, however.

Another problem arose with a subroutine designed to clear a portion of the screen. The subroutine in QuickBASIC v4.5 was

```
SUB clr(x,y)
LINE (x,y)-(320,200),0,BF
END SUB
```

In Macintosh QuickBASIC, the screen coordinates x and y had to be designated as integer variables. Hence, this subroutine was modified for the Macintosh to read

```
SUB clr(x%,y%) STATIC
LINE (x%,y%)-(320,200),0,BF
END SUB
```

The color attribute 0 in the above statement is not a valid color on the Macintosh (white has the value 30). However, this error did not prevent the program from running appropriately.

Keywords as variables

DATA is a reserved keyword in both versions of QuickBASIC, but its use as a string variable name (data$) is legal in the MS-DOS version. This is not the case in the Macintosh version. Hence, the variable data$ was changed to datr$. The problem of using keywords in other contexts also arose. One subroutine was named "cont", but because CONT is a reserved keyword, the subroutine had to be renamed.

Keywords not supported on the Macintosh

Although we attempted to restrict the use of keywords that were unique to the MS-DOS environment, it was necessary to include a number of screen related functions in the MS-DOS version of the program. These screen related definitions had to be removed before the program would run under the Macintosh environment. These statements included the following keywords.

SCREEN
COLOR
VIEW
VIEW PRINT
PAINT

A list of MS-DOS specific and Macintosh specific keywords is presented in Tables 1 and 2.

Block IF...THEN...ELSE statements

In QuickBASIC v4.5, the following construction of an IF...THEN...ELSE block, while not ideal in terms of following the flow of the program, is, nevertheless, legal.

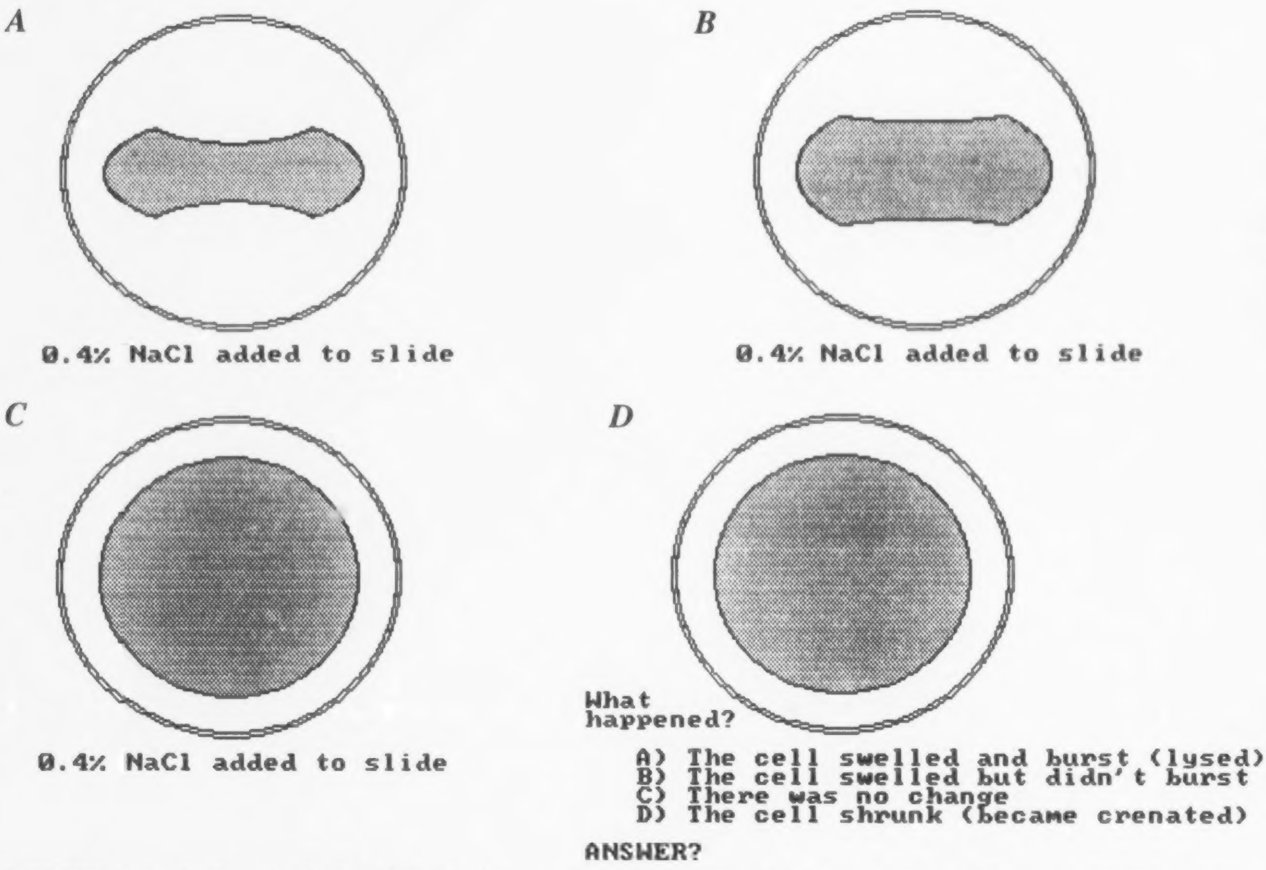
```
INPUT "answer";ans
IF ans=2 THEN
  PRINT "CORRECT"
  ELSE PRINT "SORRY"
END IF
```

In the Macintosh version, a statement cannot appear on the same line as ELSE. Hence, a few IF...THEN...ELSE blocks in the program required reformatting.

After making the changes outlined above, the program ran on the Macintosh. Although the program ran with no errors, the screen size of the MS-DOS machine and the default window on the Macintosh are different sizes. Hence, The next task was modifying the text arrangement and graphics screens to accommodate the differences in screen size and graphics routines between the two systems.

ADJUSTING TEXT OUTPUT

In the MS-DOS version of the program, text was presented either as a text screen or in combination with graphics. The 40



```
0.4% NaCl added to slide
```

```
0.4% NaCl added to slide
```

```
0.4% NaCl added to slide
```

```
What
happened?

    A) The cell swelled and burst (lysed)
    B) The cell swelled but didn't burst
    C) There was no change
    D) The cell shrunk (became crenated)

ANSWER?
```

FIGURE 1. Example of an animation in which text and graphics are combined. In panels A, B, and C, the graphic changes, but the text does not. In panels C and D, the text changes, but the graphic does not..

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column text screen on MS-DOS machines contains 25 lines. The default window used by Macintosh QuickBASIC with the default font style and size allows for a 60 column width and 17 to 18 lines. The shorter screen length necessitated modifying some text screens so that the required information could be viewed on the same screen.

Figure 1 shows an example of the a series of screens in which text was combined with graphics. In this series, the graphic portion of the screen changes, but the text label does not. After the animated series is completed, the graphic remains static, and the text portion of the screen changes. In the MS-DOS environment, this was accomplished through the use of VIEW SCREEN and VIEW PRINT statements. However, these statements are not supported in the Macintosh environment.

The easiest way to reprogram the text screens and the combined text-graphics screens was to make use of one of the text features in the Macintosh Toolbox. The Macintosh Toolbox is a set of routines, included in the Macintosh read-only memory, that provides a variety of options with which text, graphics, and aspects of the Macintosh interface can be manipulated. The Toolbox option that met our needs with respect to text handling was the TextBox routine. The TextBox routine takes the following form.

```
TEXTBOX a$, rec%(0),just%
```

When implemented, the routine draws (prints) the text in string a$ in the rectangular area designated by the array rec% with automatic word wrap. The variable, just%, defines whether the text is left justified, centered, or right justified in the box. Setting the rectangular area requires the use of another statement, SetRect. The following is an example of the SetRect statement.

```
SETRECT r%(0),0,25,485,280
```

The statement defines an array of integers named r%. r%(0) is the first element in array, and the array contains the coordinates of the rectangle stored as y1,x1,y2,x2. In this case, the upper left corner of the rectangle is at coordinates (25,0), and the lower right corner is at coordinates (280,485). An example of the results of these statements is shown in Figure 2.

GRAPHICS CONSIDERATIONS

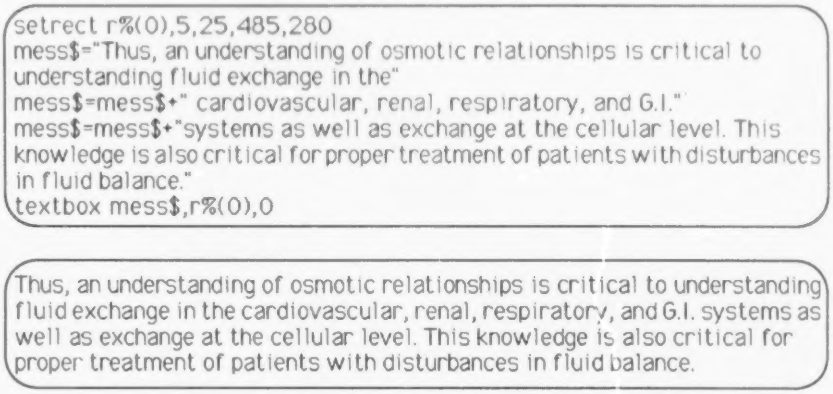
Translating the graphics from the MS-DOS representation to the Macintosh representation presented new challenges. The size of the display area for the default window on the Macintosh is 491 pixels wide and 295 pixels high. In the Screen 1 mode that we used for the MS-DOS version, the resolution was 320 X 200 pixels. Thus, the graphics statements defined in the MS-DOS version would, with slight modification, give essentially the same images on the Macintosh screen. However, the PAINT feature that allows placement of a pattern within a closed area in QuickBASIC v4.5 is not available on the Macintosh version. The solution to this apparent problem lies again in the Macintosh ToolBox functions. Figure 3 shows the representation of a red blood cell on a microscope slide achieved with the MS-DOS version and the comparable figure from the Macintosh version. The following listing generated the image in the MS-DOS version.

```
CIRCLE (120,70), 80, 3
CIRCLE (120,70), 78, 3
TILE$ = CHR$(&H22) + CHR$(&H88)
CIRCLE (80,70), 20, , PI/4, 7*PI/4
CIRCLE (160,70), 20, , 5*PI/4, 3*PI/4
CIRCLE (120,99), 42, , 5*PI/4, 7*PI/4, .5
PAINT (120,70), TILE$, 3
```

The figure is made up of two circles and a series of arcs. Four arcs intersect to form the closed biconcave representation of the red blood cell. The pattern defined by the text variable TILE$ is then "painted" into the closed figure.

The following are the steps involving the ToolBox routines that were used to generate the Macintosh graphic shown in Figure 3.

```
SETRECT pt0%(0), &H0,&H0,&H0,&H0
SETRECT pt1%(0),
&HAA55,&HAA55,&HAA55,&HAA55
SETRECT r1%(0), 60,70,100,110
```



```
setrect r%(0),5,25,485,280
mess$="Thus, an understanding of osmotic relationships is critical to
understanding fluid exchange in the"
mess$=mess$+" cardiovascular, renal, respiratory, and G.I."
mess$=mess$+"systems as well as exchange at the cellular level. This
knowledge is also critical for proper treatment of patients with disturbances
in fluid balance."
textbox mess$,r%(0),0
```

```
Thus, an understanding of osmotic relationships is critical to understanding
fluid exchange in the cardiovascular, renal, respiratory, and G.I. systems as
well as exchange at the cellular level. This knowledge is also critical for
proper treatment of patients with disturbances in fluid balance.
```

FIGURE 2. Example of the use of the TextBox statement in Macintosh QuickBASIC. *Upper Panel:* Program listing showing assignment of text to the variable mess$ and the form of the TextBox statement. *Lower Panel:* Portion of output screen showing the effects of the listing in the upper panel.

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```
SETRECT r2%(0), 140,70,180,110
SETRECT r3%(0), 78,21,165,81
SETRECT r4%(0), 78,100,162,166
SETRECT strt%(0), 60,70,180,110
CIRCLE (120,90),80,33
CIRCLE (120,90),78,33
CALL PENPAT(VARPTR(pt1%(0)))
PAINTOVAL VARPTR(strt%(0))
PAINTARC VARPTR(r1%(0)),45,-270
PAINTARC VARPTR(r2%(0)),225,-270
CALL PENPAT(VARPTR(pt0%(0)))
PAINTARC VARPTR(r3%(0)),135,90
PAINTARC VARPTR(r4%(0)),45,-90
CALL PENNORMAL
```

In this case, a number of arrays are established to define patterns or coordinate sets. The two outer circles are generated using the same statements as those used in the MS-DOS version (see Figure 4). Because the PAINT statement is not available in Macintosh QuickBASIC, the "painted" red cell is generated in a more round-about manner. In this case, the pattern used by the Macintosh "pen" to generate images is changed to that desired for the red cell. An oval and two arcs are generated using this pen pattern forming the red cell (not yet biconcave). To show the biconcave image, the pattern is changed again to provide a "blank" pen so that any lines made will "erase" the previously made pattern. Two arcs are then generated giving the image the appearance of the biconcave red blood cell in the microscope field.

Explanation of the listing

The SetRect statements establish a series of integer arrays that contain information to be used in subsequent statements. The arrays pt0% and pt1% are pattern definitions. The remaining arrays define the coordinates of rectangles that serve as the boundaries for the for the oval and for the oval from which the arcs are to be drawn. The CIRCLE statement takes the same form as in QuickBASIC v4.5. The next statement is a call to a ToolBox routine that defines the pattern that the "pen" will use "draw" lines on the screen in subsequent graphics statements.

The VARPTR function, used in the PENPAT, PAINTOVAL, and PAINTARC routines, passes information about the location of necessary information to the routine. For example, in the statement

```
CALL PENPAT(VARPTR(pt1%(0)))
```

the pen pattern routine must locate the integer array that contains the pattern to be used. VARPTR points the routine to the appropriate location.

Following definition of the pen pattern, an oval bounded by a rectangle defined by the coordinates defined in the array strt% is drawn and filled in with the current pen pattern. Two arcs are then drawn and filled to provide additional height to the basic oval that will become the biconcave image of the red cell.

The pen pattern is then changed to a white pattern that, when overlayed on the currently displayed image, will "erase" the current pattern. The biconcave image of the red blood cell is completed by drawing to additional arcs to "erase" the appropriate portion of the image. The final statement, CALL PENNORMAL, resets the pen to the default pattern.

This listing represents one example of how routines from the Macintosh ToolBox can be used to generate images that, at first, appear not possible because some of the graphics statements available in QuickBASIC v4.5 do not have exact counterparts in Macintosh QuickBASIC.

Availability of the Macintosh ToolBox to QuickBASIC offers a number of capabilities not offered by the MS-DOS version of QuickBASIC. For example, the ToolBox allows access to mouse commands, text size and font, pull-down menus, and other features of the Macintosh interface. Unfortunately, the documentation in the Macintosh QuickBASIC manual leaves something to be desired with respect to using ToolBox capabilities. A more detailed explanation of the ToolBox options can be found in the Apple Inside Macintosh series[1] and in Stephen Chernicoff's Macintosh Revealed series.[2]

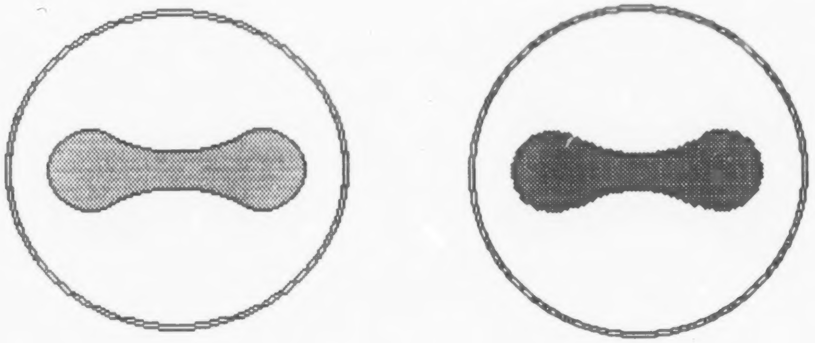

FIGURE 3. Graphic representation of a red blood cell within a microscope field. *Left Panel:* Graphic as it appears on an MS-DOS machine. *Right Panel:* Graphic as it appears on a Macintosh. See text for details.

CONCLUDING COMMENTS

QuickBASIC does not provide the ideal environment for creating software that can be used on both MS-DOS and Macintosh equipment. However, if care is taken to avoid certain features of the language that are specific to MS-DOS systems, and with some advance planning, porting software from MS-DOS to Macintosh systems can be accomplished without too much difficulty. The documentation supplied with the software offers very little help in this task. Perhaps the best publication providing guidance in determining compatibility among versions of QuickBASIC is The Waite Group's Microsoft Quickbasic Bible.[7]

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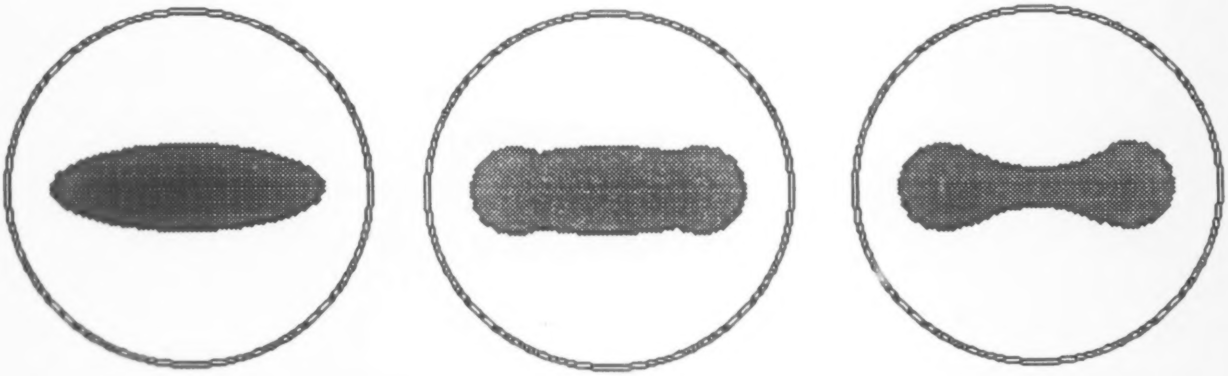

FIGURE 4. Graphic steps used to generate red blood cell representation in Macintosh QuickBASIC. *Left Panel:* Initial oval. *Middle Panel:* Initial oval with two arcs to provide "painted" area. *Right Panel:* Portion of the shaded area is "erased" to yield biconcave red blood cell representation. See text for details.

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 89

DESIGNING PROTOCOLS FOR STUDENT LABORATORIES 91
Harold I. Modell

INDEX FOR VOLUME 8 94

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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REMINDER

This issue of CLSE is the final issue published monthly. Volume 9 (1992) will mark our change from a monthly to a quarterly publication. The next issue of CLSE will be appear in March, 1992.

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DESIGNING PROTOCOLS FOR STUDENT LABORATORIES

Harold I. Modell

National Resource for Computers in Life science Education, Seattle, Washington

Simulations of biological systems can provide students with a vehicle for exploring the underlying concepts that govern those systems. The simulation provides a pseudo-scientific environment in which the student can pose hypotheses, design experiments to test those hypotheses, and run the experiments. The end result can be a valuable active learning experience in which the student reasons from basic facts to general concepts. Whether working with a given simulation results in a valuable learning experience or merely another exercise to be completed to receive a grade in the course depends, to a large extent, on the direction provided to the student. In 1974, we approached this issue with respect to a set of simulations in respiratory physiology.[1] The question that we asked at that time was, "How much direction should be given to the student working with a given model?" We considered a spectrum from providing no direction to providing direction to the point where the entire scope of the study along with all possible ramifications were covered. If no direction was provided, students would have to rely solely on past experience and their understanding of the modeled system for the scope of the study and specific data values. At the other end of the spectrum, there would be no need to work with the model. Because the whole study along with the implications of the results are presented, the active learning element would be lost. We concluded that the direction provided should be similar to that given in a student laboratory protocol in which one possible study with sample values and suggestions for analyzing the data is given to the student.

PRESENTATION MODE

A question that we did not deal with because of computer memory limitations that existed in 1974 but which is appropriate with today's microcomputer capabilities is, "Should the direction be provided by the computer, or should it be given in the form of a handout?" There are pros and cons to both of these options. Providing direction in the form of a handout provides considerable flexibility in terms of student populations and educational settings. If instructors prefer a different protocol than the one provided with the program, all that is needed is to provide students with a different handout. Thus, one program can service a variety of population merely by tailoring the handout to the knowledge and experience level of the students. The handout option also makes the program easier to use in a group discussion setting. In this case, the group leader or a consensus of group determines the scope of the study without interference from the program. The third major advantage of the handout approach is that the student is able to walk away from the computer with a summary of the experiment, the data obtained, and the interpretation of the data. The primary drawback of this approach is that there is no guarantee that the student will go through the suggested protocol and answer all of the questions as the author intended.

Providing the direction as part of the program ensures a higher probability that the student will approach the simulation in the manner intended. It also allows for the possibility of incorporating a tutorial aspect into the program. Thus, students can be assisted in designing the experiment and in data analysis as in the handout mode, but they can also be queried to determine if they have appropriately interpreted their results. If their responses indicate that they do not understand underlying concepts, remedial help can be offered at a time when it has a high probability of being effective.

DESIGN OF THE PROTOCOL

The design of the protocol, that is, the way in which the protocol is presented to the student, is a critical factor in determining if the exercise will be a meaningful learning experience for the student. This is true for all student laboratories, not just computer-based exercises. An examination of "traditional" student laboratory protocols from biology, physics, chemistry, and, indeed, most science curricula, reveals an interesting pattern. The pattern is evident, at its extreme, in the protocol presented in Figure 1. The procedure generally tells the student to "do this", "record this", "tell me what you saw", and, in some cases, "interpret what you saw," or it asks "what are the implications of what you saw?"

In this approach, students are certainly engaged in a discovery process. They make observations and either try to explain those observations or memorize those observations to enlarge their factual database relevant to that system. In either case, they are not necessarily engaged in a scientific process, the very process that these laboratories are purported to help students learn. What is the difference? The "traditional" protocol does not encourage students to make

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SOUND LABORATORY (A)

Objective: To explore the mechanism of sound production in woodwind intruments.

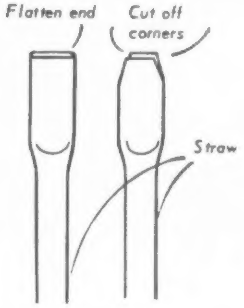
Materials: Several drinking straws, scissors

Procedure:

1. Pinch one end of a drinking straw for about 3/4 of an inch from the end. Blow gently through the straw. Record what you hear on the data table below.
2. Cut the corners of the flat end of the straw off diagonally with the scissors (see illustration). Now blow gently through the "reeds" that you've made so that the "reeds" vibrate. It takes a little practice to find out how hard to blow and how to adjust the "reed" with you lips to vibrate it. Record what you hear on the data table below.
3. Shorten the length of the straw by cutting a 2-inch piece off of the non-reed end. Blow your "instrument" again. Compare the pitch of the sound to the previous trial. Repeat this experiment.
4. Make a second "instrument." In this straw, cut a finger hole about 2 inches from the non-reed end, and cut a second finger hole about 4 inches from the non-reed end. Blow the instrument first with the finger holes covered and then with each of the finger holes open. Compare the pitch of the sound obtained with both finger holes open to that obtained from the shorter instrument from step 3.

Questions:

1. Why wasn't a sound produced when you blew on the original straw?
2. What happened to the air in the straw when the "reeds" vibrated?
3. Is it the vibrating "reeds" or the vibrating air column that makes the sound coming from your "instrument?"
4. What effect did opening the finger holes have on the column of air in the instrument?



DATA TABLE

Instrument design	Sound produced
Straw with pinched end	
Full length straw with reeds	
Straw with reeds shortened by 2"	
Straw with reeds shortened by 4"	
Straw with reeds and finger holes	

FIGURE 1. Example of student laboratory protocol that follows a traditional format.

hypotheses *before* running the experiment. Thus, they do not know why they are running a specific experiment.

Figure 2 presents another version of the protocol for the experiment described in Figure 1. In this version, the student is asked to make a prediction (i.e., pose an hypothesis) before running the experiment (cf Step 3). The intent of this version is to help the student think about the underlying concepts or mechanisms while doing the experiment. By making a prediction, students must form some mental model of how the system works. The experiment, then, becomes a vehicle for testing that model.

AN EXPERIMENT

As part of a recent faculty development workshop, the following informal experiment was conducted to see if the protocol format influenced the "students'" perception of the experience. The "students" in the case were physiologists, biomedical engineers, clinicians, and a few administrative personnel who were attending the workshop. The "class" was divided into 5 lab groups of 4-5 "students" each. Three lab groups were given the protocol shown in Figure 1 (Protocol A), and the other two were given the protocol shown in Figure 2 (Protocol B). The groups were given the necessary supplies and were allowed 15-20 minutes to complete the exercise.

During the "laboratory period," the "instructor" interacted with one of the Protocol A groups by asking group members questions about their observations and how they interpreted their results and by asking them to predict the results of the subsequent steps in the protocol. No interaction of this type was attempted with any of the other groups.

When the time allotment had expired, each group was asked how they approached the laboratory. The two Protocol A groups that did not interact with the instructor followed the protocol in a "cook book" manner with very little within group interaction. Each group member worked with his or her own straw and followed the steps in order without giving much thought to the underlying mechanisms. When these groups reached the questions, they did not readily associate what they had done in the protocol with the questions. This response was interesting because the "students" were, in fact, experienced, practicing scientists. Yet, when placed in a student mode, their goal was to complete the exercise in the shortest possible time without giving much thought to the principles on which their observations were based.

The groups with Protocol B approached the exercise in an entirely different man-

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ner. Each group member worked with their own straws much as the Protocol A group members did. However, the Protocol B groups discussed each step, their observations, and the explanation for their observations with their colleagues during the entire exercise. They became interested in the underlying science, and they extended the scope of their experiments more than did the Protocol A groups.

The Protocol A group that interacted with the instructor began the exercise in the same manner as the other Protocol A groups. However, after the instructor's intervention, their approach became closer to those groups who were assigned Protocol B. Thus, in this instance, the shortcomings of the Protocol A format were overcome to some extent by instructor intervention.

IMPLICATIONS FOR COMPUTER-BASED EXERCISES

One of the advantages often ascribed to computer-based exercises is the capability to have smaller lab groups than traditional wet labs. In addition, computer-based exercises may also be run in an independent study setting. In both of these cases, the emphasis is that more students can interact with the "preparation" than they can in the traditional laboratory setting. However, as the number of groups increases, the number of groups with which the instructor can interact in a given time period decreases. Hence, it may be difficult or impossible for instructors to interact with the class in the same way as it was in the traditional laboratory, and the chances to compensate for poorly designed protocols are diminished. It is critical, therefore, that the direction provided to students is designed to foster the kind of thought process that will lead to integration of concepts. Protocols should encourage students to test their own concepts. To do this, students must think about the system *before* running the experiment as well as after they see the results of the experiment. "From what you know about the system, what do you think will happen if factor X is changed?" "Did the data support your hypothesis?" "What additional factors must you take into account?" "How must our (your) model of

SOUND LABORATORY (B)

Objective: To explore the mechanism of sound production in woodwind instruments.

Materials: Several drinking straws, scissors

Procedure:

1. Pinch one end of a drinking straw for about 3/4 of an inch from the end. Blow gently through the straw. Was a sound (a "note") produced by blowing through the straw? Is that what you would have predicted? Why?

2. Cut the corners of the flat end of the straw off diagonally with the scissors (see illustration). Now blow gently through the "reeds" that you've made so that the "reeds" vibrate. It takes a little practice to find out how hard to blow and how to adjust the "reed" with you lips to vibrate it. What happens to the column of air in the straw when the "reeds" vibrate? What do you hear when the reeds vibrate?

3. Is it the vibrating "reeds" or the vibrating air column that makes the sound coming from your "instrument?" Shorten the length of the straw by cutting a 2-inch piece off of the non-reed end. Blow your "instrument" again. what have you done to the "reeds?" What has happened to the air column? Compare the pitch of the sound to the previous trial. What would happen if you shortened the straw again? Repeat this experiment. Was your prediction correct?

4. Can the air column be shortened without shortening the straw? Make a second "instrument." In this straw, cut a finger hole about 2 inches from the non-reed end, and cut a second finger hole about 4 inches from the non-reed end. Blow the instrument first with the finger holes covered and then with each of the finger holes open. What happens to the pitch of the "note" when the finger holes are opened? Compare the note obtained with both finger holes open to that obtained from the shorter instrument from step 3. What has opening the finger holes done to the air column?

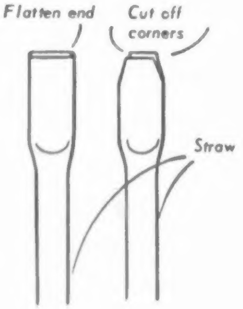

FIGURE 2. Example of a "process oriented" student laboratory protocol.

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the system be modified?"

Traditionally, student laboratory protocols have focused only on the specific phenomenon being examined. Little attention was paid to helping the student develop a paradigm for conducting a meaningful study. If students are to gain maximum benefit from using computer simulations of biological systems, they must become adept at using the process of scientific inquiry to test the model being examined. The direction that we provide students must be designed to help them learn this process.

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COMPUTERS IN LIFE SCIENCE EDUCATION, VOLUME 8 INDEX

- anatomy
  - colleagues 6:50, 9:67
  - software 4:25-26
  - videodiscs 2:13
- animation 8:59
- annual report, NRCLSE 1:1-3
- Authorware Professional 8:58

- BICEP 3:17-19
- biochemistry
  - colleagues 7:51
  - software 4:26
- biology
  - colleagues 7:51-53
  - courseware 3:17-19
  - software 3:17-19, 4:26-27
  - videodiscs 2:14
- biotechnology videodisc 2:14
- botany
  - colleagues 7:53-54
  - software 4:27-28
  - videodiscs 2:14

- cell biology
  - colleagues 7:54
  - videodiscs 2:14-15
- clinical medicine
  - colleagues 8:62, 8:63, 9:69, 10:75
  - software 4:28-30
  - videodiscs 2:15, 3:20-21
- CLSE
  - colleague directory 7:49-55, 8:61-63, 9:66-71, 10:74-75
  - format change 10:73-74
- colleagues
  - agronomy 7:49
  - anatomy 7:50
  - animal behavior 7:50
  - animal science 7:51
  - biochemistry 7:51
  - biology 7:51-53
  - biometrics 7:53
  - biophysics 7:53
  - biostatistics 7:53
  - botany 7:53-54
  - cell biology 7:54
  - chemistry 7:54
  - computer literacy 7:54
  - cytogenetics 7:54
  - cytology 7:54
  - dentistry 7:54
  - developmental biology 7:54
  - ecology 7:55
  - education 7:55
  - electron microscopy 8:61
  - embryology 8:61
  - endocrinology 8:61
  - entomology 8:61-62
  - environmental science 8:62
  - epidemiology 8:62
  - evolution 8:62
  - family practice 8:62
  - fisheries 8:62
  - gastroenterology 8:62
  - genetics 8:62-63
  - hematology 8:63
  - histology 8:63
  - immunology 8:63
  - instructional design 8:63
  - internal medicine 8:63
  - laboratory medicine 9:66
  - limnology 9:66
  - livestock production 9:66
  - marine science 9:66
  - medical technology 9:66-67
  - microanatomy 9:67
  - microbiology 9:67
  - modeling 9:67
  - molecular biology 9:67-68
  - molecular genetics 9:68
  - natural history 9:68
  - neuroanatomy 9:68
  - neurobiology 9:68
  - neuroscience 9:68
  - nursing 9:68
  - nutrition 9:68
  - oral histology 9:68
  - oral pathology 9:68
  - ornithology 9:68-69
  - parasitology 9:69
  - pathology 9:69
  - pediatrics 9:69
  - pharmacology 9:69
  - physiology 9:69-71, 10:74-75
  - plant physiology 10:75
  - population biology 10:75
  - psychiatry 10:75
  - quantitative biology 10:75
  - research techniques 10:75
  - serology 10:75
  - statistics 10:75
  - taxonomy 10:75
  - virology 10:75
  - zoology 10:75
- college freshmen 3:17-19
- courseware
  - biology 3:17-19
  - developing 8:57-60
- cytology
  - colleagues 7:54
  - software 4:30

0742-3233/91/$0.00 + 2.00

- dental health care videodiscs 3:21

- ecology
  - colleagues 7:55
  - software 4:30, 5:33-34
- electronic lecture hall 2:10
- evolution
  - colleagues 8:62
  - software 5:34

- forestry software 5:34

- genetics
  - colleagues 8:62-63, 9:68
  - software 5:34-35
- graphics 8:58-59, 11:85-86

- health science videodiscs 3:22
- hematology
  - colleagues 8:63
  - videodiscs 3:22
- histology
  - colleagues 8:63
- Hypermedia 2:9-13
- Hypermedia lab 2:11

- interactive video 2:13-15, 3:20-23

- Keeping Abreast of the Literature 3:20, 6:41-42, 9:65-66, 12:89-90
- Kolitsky, MA 2:9-13

- laboratory protocols 12:91-94

- Macintosh 11:81-87
- medicine software, clinical 4:28-30
- microbiology
  - colleagues 9:67
  - software 5:35
  - videodiscs 3:22
- miscellaneous software 6:45-46
- Modell HI 10:73-74, 11:81-87, 12:91-94

- neuroscience
  - colleagues 9:68
  - software 5:35-36
- NRCLSE
  - annual report 1:1-3
  - reader survey 1:5-6
  - questionnaire 1:7
  - software evaluation submission form 10:76-78
- nursing
  - colleagues 9:68
  - software 5:36

- optical data design center 2:12-13

- pathology
  - colleagues 9:69
  - videodiscs 3:22-23
- pharmacology
  - colleagues 9:69
  - software 5:36
- physiology
  - colleagues 9:69-71, 10:74-75
  - software 1:3-4, 5:36-38, 6:43-45
  - videodiscs 2:13
- population dynamics software 6:45
- programming 8:58, 11:81-87
- protocol design 12:91-94

- QuickBASIC 11:81-87

- Ralph CL 3:17-19, 8:67-60

- science center 2:9-13
- screen design 8:60
- simulation 8:58, 12:91-94
- software
  - anatomy 4:25-26
  - biochemistry 4:26
  - biology 3:17-19, 4:26-27
  - botany 4:27-28
  - clinical medicine 4:28-30
  - cytology 4:30
  - ecology 4:30, 5:33-34
  - evolution 5:34
  - forestry 5:34
  - genetics 5:34-35
  - microbiology 5:35
  - miscellaneous 6:45-46
  - neuroscience 5:35-36
  - nursing 5:36
  - pharmacology 5:36
  - physiology 1:3-4, 5:36-38, 6:43-45, 11:81-87
  - population dynamics 6:45
  - zoology 6:45
- student laboratories 12:91-94

- tutorials 8:58

- vendors
  - software 3:30-31, 4:30-31, 5:38-39, 6:46-47
  - videodisc 2:13-15, 3:20-23
- videodiscs
  - anatomy 2:13
  - biology 2:14
  - biotechnology 2:14
  - botany 2:14
  - cell biology 2:14-15
  - clinical medicine 2:15, 3:20-21
  - dental health care 3:21
  - health science 3:22
  - hematology 3:22
  - microbiology 3:22
  - pathology 3:22-23
  - pathophysiology 5:40
  - physiology 2:13
  - wildlife management 3:23
  - zoology 3:23

- wildlife management videodisc 3:23
- Where are the Videodiscs? 2:13-15, 3:20-23
- Where's the Software? 4:25-31, 5:33-39, 6:43-47

- zoology
  - colleagues 10:75
  - software 6:45
  - videodiscs 3:23

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

NRCLSE ANNUAL REPORT FOR 1991 1

KEEPING ABREAST OF THE LITERATURE 3

WHERE'S THE SOFTWARE? 3

NRCLSE SOFTWARE EVALUATION SUBMISSION FORM 21

NRCLSE ANNUAL REPORT FOR 1991

The overall purpose of NRCLSE is to cultivate collaborative efforts among faculty with expertise in using computers in life science education. The broad goal of the Resource is fourfold:

1) to educate faculty in effective uses of computers in the curriculum;
2) to promote research aimed at evaluating new applications of the computer to life science education;
3) to promote development of a critical mass of high quality, versatile software, and
4) to serve in a consultant capacity for life science faculty currently active or interested in becoming active in this area.

This year's activities continued our efforts to serve the life science community. A statement of NRCLSE's financial status is presented in Table 1.

GENERAL OVERVIEW OF ACTIVITIES

Publication of Computers in Life Science Education continued to be NRCLSE's primary activity in 1991. However, during the past year, we continued to provide information to colleagues throughout the world concerning use of computers in life science curricula, participate in national meetings, conduct demonstrations at several institutions, and distribute our Simulations in Physiology software. We have also begun developing a new set of simulations focused on renal physiology. The series is expected to be ready for distribution in the fall of 1992.

Computers in Life Science Education
Subscriptions to CLSE continue at the same level as in previous years, with about 45% of the subscriptions being held by libraries. The student population addressed by subscribers ranges from the

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Table 1. NRCLSE Financial Report for year ending December, 1991.

Fund Balance, December 31, 1990		**$13,647**
Revenues		
Cash donations	1,000	
Subscriptions/Reprints	4,706	
Software/Manual sales	2,550	
Total Revenues	8,256	
Expenses		
CLSE production	3,797	
Postage/Shipping	2,008	
Operating expenses supplies, phone, etc.	1,693	
Travel	433	
Equipment	850	
Total Expenses	8,781	
Decrease in fund balance	(525)	
Fund balance, December 31, 1991		**$13,122**

high school level through the post-graduate level. About half of the subscribing institutions focus on undergraduate education, and about one third focus on medical education. The geographic distribution of subscribers continues to be broad. In addition to the U.S. and Canada, subscribers for 1991 included institutions in France, Germany, Great Britain, Israel, Norway, the Philippines, Spain and Sweden.

Software distribution

In 1991, twenty-one sets of our simulations were distributed. Currently, 136 institutions representing eighteen countries on four continents have purchased one of the microcomputer versions of Simulations in Physiology - The Respiratory System. Six sets of our Common Themes in Physiology series were also distributed in 1991.

Resource Information

During 1991, NRCLSE responded to 60 requests for information concerning use of the computer as an educational tool. As in previous years, the geographic origin of the requests continues to reflect our goal of providing worldwide service. Requests in 1991 were received from seventeen countries in addition to the United States.

Presentations/Consultation

Dr. Modell led workshops at two institutions in 1991 focusing on promoting active learning in the classroom and the potential roles for computers in fostering an active learning environment.

NRCLSE also visited one medical school in 1991 to demonstrate the use of the computer to foster active learning in the classroom and discuss uses of computers in the basic science curriculum.

New software initiative

NRCLSE began work on a new software package this year. The package will consist of a series of simulations and tutorials focused on renal physiology. The package, which should be ready for distribution in the fall of 1992, includes three tutorials and five simulations. The three tutorials utilize qualitative simulations in a format similar to the Osmosis tutorial in our Common Themes in Physiology series to help acquaint students with concepts related to water movement across membranes, solute transport mechanisms, and the renal concentrating mechanism. The remaining five programs are quantitative simulations, four of which are based on the research model of Roman and Sias (*Mathematical Modelling* 7:1045, 1986), that require students to enter values for a set of variables and provide data consistent with those values. Design of the input/output screens, the error messages presented, and the accompanying student "laboratory" manual follow the same general philosophy as that governing Simulations in Physiology - The Respiratory System. The simulations cover glomerular capillary dynamics; sodium, bicarbonate, chloride and water reabsorption in the proximal tubule; salt and water transport in the distal nephron; the interaction of neural and hormonal factors on urine formation in the whole nephron; and general principles of acid-base balance. The simulations will be presented at the annual meeting of the Federation of American Societies for Experimental Biology (FASEB) to be held in Anaheim, CA in April.

Special thanks

NRCLSE extends a very special "Thank you" to the following people, organizations, and institutions for their support in 1991.

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KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a regular feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WHERE'S THE SOFTWARE?

In the past, we have published lists of life science software sources and programs available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

The listings are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on pages 18-20.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to:

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ANATOMY

ANATOMY HELPER-BRAIN

Drill and practice program that contains 13 human brain sections with substructures identified. CHARIOT SOFTWARE GROUP

ANATOMY OF A FISH

Tutorial/game presenting information on the external, internal, and skeletal structures of a bony fish. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

ANATOMY OF A SEA LAMPREY

Tutorial/game presenting information on the life cycle and anatomy of a sea lamprey. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

COCHLEAR ANATOMY: A MACINTOSH TOUR

HyperCard courseware that provides an anatomical tour through the hearing portion of the mammalian inner ear. Available for Macintosh equipment. INTELLIMATION FOR THE MACINTOSH

BODY LANGUAGE I, II, III, IV

A series of drill and practice reviews of anatomical terms. Available for Apple II and IBM-PC compatible equipment. EDUCATIONAL SOFTWARE PRODUCTS

GROSS ANATOMY TUTORIAL

Tutorial for gross anatomy review by region and for self-test in National Board format. Program available for Apple II equipment. LIFE SCIENCE ASSOCIATES

HEART LAB

Animated graphics simulation of human heart. Program available for Apple II equipment. EDUCATIONAL ACTIVITIES, INC.

HUMAN ANATOMY PICTURE FILE

Hi-Res diagrams of heart, brain, eye, ear, respiratory system, kidney, endocrine system, neurons, circulatory system schematic, and digestive system. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

LOCOMOTION

Tutorial reviewing types and functions of bones and muscles. Program available for Apple II equipment. J & S SOFTWARE

NEUROANATOMY FOUNDATIONS

HyperCard based computer atlas of brain anatomy. Includes digitized images of three-dimensional dissections, diagrams, and text. Available for Macintosh equipment. INTELLIMATIONS LIBRARY FOR THE MACINTOSH

OCULAR ANATOMY TUTOR

HyperCard-based tutorial to help optometry and opthamology students learn the anatomy of the eye. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

THE HUMAN BODY: STRUCTURE AND FUNCTION

HyperCard adjunct to basic human anatomy. Program incorporates diagrams of basic anatomy that are linked to labels and glossary cards. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

BIOCHEMISTRY

ANIMATED PATHWAYS OF BIOCHEMISTRY

Simulation of molecules colliding and reacting. Available for IBM-PC compatible equipment. WILLIAMS & WILKINS

ANIMATIONS

Contains animations for demonstrating DNA structure and synthesis, RNA structure and synthesis, and protein synthesis. Program available for Apple II equipment. ALBION

BASIC BIOCHEMISTRY

Tutorial to help students understand metaoblis; includes five modules - overview of metabolism, glucose metabolism, TCA cycle, fatty-acid metabolism, and urea cycle. Available for Macintosh equipment. CHARIOT SOFTWARE GROUP

BIOCHEMISTRY

Tutorial covering basic atomic structure, balancing equations, and properties of proteins and carbohydrates. Program available for Apple II equipment. J & S SOFTWARE

BIOCHEMISTRY EXAM/TUTORIAL

Covers basic fuel metabolism. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

CONCENTRATED CHEMICAL CONCEPTS: BIOLOGICAL CHEMIST

Drill and practice program covering an entire introductory course in organic chemistry for health science majors. WILEY PROFESSIONAL SOFTWARE

DNA STRUCTURE AND SYNTHESIS

Tutorial dealing with nucleotide structure and linkage between nucleotide, base complementarity and hydrogen bonding. Program available for Apple II equipment. EDUTECH, INC.

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced), IBM-PC compatible and Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

ENZKIN: Enzyme Kinetics

Simulation of enzyme-catalyzed reactions. Program available for Apple II equipment. CONDUIT

ENZLAB

Simulations for designing and carrying out enzyme kinetics experiments. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

ENZPACK

An enzyme kinetics teaching and calculation program. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

ENZYME ACTION

Tutorial on the basic nature and function of enzymes. Program available for Apple II equipment. BIOSOFT

ENZYME-SIMULATION, ENZYME ACTION

Simulation of enzyme action and the effects of inhibitors using acetylcholinesterase. Program available for Apple II, IBM-PC and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GENE MACHINE

Tutorial/Simulation dealing with DNA replication and protein synthesis. Program available for Apple II equipment. HRM SOFTWARE

MOLECULAR BIOLOGY SERIES

Programs demonstrating central processes of RNA and protein synthesis and DNA synthesis and repair. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

MOLGRAF

Molecular graphics package. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

THE NUCLEIC ACIDS

Tutorial/Simulation dealing with principal nucleotides and synthesis of RNA. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

PROTEIN SYNTHESIS

Tutorial dealing with the general structure of the amino acids and formation of peptide bonds. Program available for Apple II equipment. EDUTECH, INC.

RNA STRUCTURE AND SYNTHESIS

Tutorial extending the concept of hydrogen bonding between complementary bases to show the synthesis of RNA on the DNA template and the analogies in structure between DNA and RNA. Program available for Apple II equipment. EDU TECH, INC.

SYSCHEM I

Tutorial covering biochemistry and organic chemistry focusing on the TCA cycle, the urea cycle, glucose metabolism, fatty-acid metabolism and a biochemical overview. Available for Macintosh equipment. IRVINE INTERACTIVE INC

BIOLOGY

ADAPTION AND IDENTIFICATION

Tutorial covering animal adaptation to different environments and animal identification. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ANIMAL REPRODUCTION

Tutorial reviewing sperm development, egg and fertilized egg. Program available for Apple II. J & S SOFTWARE

ANTS - RELIABILITY THEORY & ANT FORAGING MODEL

An interactive program to study the system reliability of different ant foraging strategies. Available for IBM-PC compatible equipment. WISC-WARE

ASEXUAL REPRODUCTION

Tutorial reviewing cell division. Program available for Apple II equipment. J & S SOFTWARE

BIOLOGY 1/BIOLOGY 2

Tutorials covering a wide range of topics in biology. Available for IBM- PC compatible equipment. INTELLECTUAL SOFTWARE

BIOLOGY COMPUTER STIMULATIONS

Tutorial covering various biological concepts and experimental areas including enzymes, photosynthesis, respiration, diffusion, meiosis, muscles, nerves, and genetics. Program available for Apple II equipment. LIFE SCIENCE ASSOCIATES

BIOLOGY COURSEWARE

Series of 52 tutorial and simulations programs covering most topics covered in a two-semester, freshman biology course. Available for Macintosh equipment. OMEGAWARE

BIOLOGY DISSECTION FROG

Dissection guide that teaches students how to dissect a frog. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY LAB DISSECTIONS

Seven dissection guides teach students about seven different animals: Frog, Earthworm, Grasshopper, Crayfish, Starfish, Clam and Perch. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY SIMULATIONS PACKAGE III

Three collections of simulations covering aspects of genetics, natural selection, and predator-prey interaction. Available for Apple //e (enhanced) equipment. ALBION

BIO PHYLA FAUNA

Includes 190 graphics of fauna from protozoans through chordates. Program lets user exand or contract fauna and add labels. CHARIOT SOFTWARE GROUP

BIOQUEST

A series of simulations in biology aimed at helping students learn problems solving. Available for Macintosh equipment. JUNGCK, DR. JOHN

BIRD LEXI

Contains an alphabetical list of every word in the species, genus, family, and order names of the 9700 birds in James Clements' *Birds of the World*. Available for IBM-PC compatible equipment. SANTA BARBARA SOFTWARE

CELLS

Simulation of experiments in tracking the movement of cells through the four-state mitotic cell cycle. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

CREATE A TEST/CREATE A TEST QUESTION FILES-BIOLOGY

Test creation program and 4800 question bank in biology. Available for Commodore 64, Apple II and IBM-PC compatible equipment. CROSS EDUCATIONAL SOFTWARE

DIFFUSION AND ACTIVE TRANSPORT

Tutorial covering diffusion, osmosis, and active transport in biological systems. Program available for Apple II equipment. SIMPAC EDUCATIONAL SYSTEMS

EFFECT OF SIZE ON MOUSE METABOLISM

HyperCard stack that describes the effects of mouse size on the metabolic rate. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

ENERGETICS AND METABOLISM, GARDEN OF BIOLOGY: VOLUME 1

Data base illustrating reactions of metabolism and interactions between the several metabolic compartments of a cell. Program available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

EVOLUTION, GARDEN OF BIOLOGY: VOLUME 2

Data base illustrating relations among organisms of many kinds, emphasizing the history and mechanics of their evolutionary change. Program available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

FASCINATING STORY OF CELL GROWTH

Tutorial covers surface area/cell volume, experimenting with cell size, chromosomes in cell division and stages of mitosis. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HOW'S AND WHY'S OF MIGRATING MOLECULES

Tutorial covering transport through a membrane, osmosis and diffusion. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HUNTINGTON I SIM PROG - BIOLOGY

Seven simulations for use in introductory level biology courses. Available for DEC equipment. HUNTINGTON COMPUTER PROJECT

KNOWLEDGE MASTER - BIOLOGY 2

Test-item database for test generation. Content covers coelenterates, arthropods, insects, fish, amphibians, and reptiles. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

KNOWLEDGE MASTER - BIOLOGY 3

Test-item database for test generation. Content covers birds, mammals, primates, protists, bacteria and taxonomic zoology. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

MACFROG

Interactive laboratory that simulates a frog dissection. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MARINE INVERTEBRATES

Tutorial covering animals from the Phylums Porifera, Mollusca, Coelenterata, and Echinodermata. Avaialable for Apple II equipment. VENTURA EDUCATIONAL SYSTEMS

MIND GAMES - BIOLOGY

Game format to review basic concepts in biology. Available for Apple II and IBM-PC compatible equipment. DIVERSIFIED EDUCATION ENTERPRISES

MOLECULAR BIOLOGY OF THE CELL TEXTSTACK

Hypertext version of the 1,200 page text of *Molecular Biology of the Cell, 2nd Ed.* Requires HyperCard. Available for Macintosh equipment. KEYBOARD PUBLISHING

MOLECULAR CLONING

Tutorial that uses text and animation to demonstrate the principles and techniques of molecular cloning. Requires HyperCard. Available for Macintosh equipment. KEYBOARD PUBLISHING

ORIGIN OF LIFE

Simulation of the process of chemical evolution. By experimenting with atmospheric composition, temperature, ultraviolet light and electrical energy, students determine the environment most likely to promote the formation of the chemical building blocks needed for the development of life. Available for Apple II adn IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

OSMO- OSMOSIS IN RED BLOOD CELLS

Simulation of red blood cells in hypertonic, hypotonic, and isotonic solutions. Program available for Apple II, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

OSMOSIS LAB

Simulation that illustrates hypotonic, isotonic and hypertonic solutions, cytolysis, and plasmolysis. Available for Apple II nad IBM-PC compatible equipment. EDUCATIONAL EQUIPMENT & MATERIALS CO.

OSMOTIC PRESSURE

Simulation of thistle tube experiments and animation of a molecular model for osmosis. Program available for Apple II equipment. CONDUIT

PASSIVE TRANSPORT

Tutorial-simulation covering diffusion and osmosis. Program for MS-DOS compatible equipment. CLASSROOM CONSORTIA MEDIA, INC.

PLANT AND ANIMAL CELLS

Tutorial covering the general structure of plant cells, photosynthesis, the genral stucture of animal cells, and mitosis. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

SIMULATION OF HEMOGLOBIN FUNCTION

Simulations of hemoglobin and myoglobin functions. Program for Apple II equipment. QUEUE, INC.

TAADS

Simulation game to introduce students to both laboratory techniques and the scientific method. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

THE INSECT WORLD

Simulation/tutorial covering insect types, body parts, and survival. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

BOTANY

ALGAL GROWTH

Simulation of the effects of eight variables on growth of algae. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

BIOLOGY FRUIT KEY

Identifies 125 trees and shrubs. Program available for Atari 400/800 equipment. DYNACOMP, INC.

BOTANY ON DEC

Three data analysis programs to accompany student laboratory experiments in plasmolysis, respiration and surface-volume ratio. Available for DEC equipment. THE CLEARINGHOUSE

CALIFORNIA OAKS STACK

Helps students learn vocabulary of plants in the beech family and identify the oaks of California. Requires HyperCard. Available for Macintosh equipment. CHARIOT SOFTWARE GROUP

COMPETE:Plant competition

Simulation of experiments involving interaction between flowering plants. Program available for Apple II equipment. CONDUIT

EARLY ANGIOSPERMS: A FOSSIL VIEW

Tutorial utilizing the fossil record to explain the development of flowering plants. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

EPIGRAPH - PLANT DISEASE EPIDEMIIC SIMULATION

Simulation designed to teach students some basic concepts in disease epidemiology. Available for IBM-PC compatible equiment. WISC-WARE

EXPLORING THAT AMAZING FOOD FACTORY, THE LEAF

Tutorial covers transport in the leaf, structure of the leaf and stomate action in gas exchange. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

FAMILY IDENTIFICATION

Data retrieval program to review the characteristics of 74 North American flowering plant families. Program available for Apple II equipment. CONDUIT

HOW PLANTS GROW: THE INSIDE STORY

Tutorial covers growth of the plant, stem cross section, terminal bud and plant hormones. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

LEAF: STRUCTURE AND FUNCTION

Tutorial-simulation covering the anatomy and physiology of the leaf with respect to its role as the "chemical factory" of the plant. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PHOTOSYNTHESIS AND LIGHT ENERGY

Simulation focuses on characteristics

of light and its role as an energy source. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PHOTOSYNTHESIS AND RESPIRATION

Demonstration and simulations focusing with light and dark reactions of photosynthesis, respiration, and ATP cycle. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

PHOTOSYNTHESIS & TRANSPORT

Tutorial dealing with photosynthesis and transport in plants. Program available for Apple II equipment. J & S SOFTWARE

PHOTOSYNTHESIS: UNLOCKING THE POWER OF THE SUN

Tutorial includes light as energy, light characteristics, wave length of light used by chromoplasts, variables and controls. Available for IBM- PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

PLANT ANATOMY PICTURE FILE

Hi-Res diagrams of roots, stem cross-section, leaf cross-section, photosynthesis, flowers, seeds, and germination. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

PLANT GROWTH

Tutorial-simulation covering physiology of growth beginning with the seed. Covers hormone control, feedback mechanisms, transport, and differentiation. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PLANT LIFE CYCLE GAMES

Four short drill programs cover the life cycles of mosses, ferns, and gymnosperms, and angiosperms. Available for DEC equipment. THE CLEARINGHOUSE

PLANT PAINT 2.0

A set of 72 graphics images illustrating concepts in plant biology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

PLANT-PLANT GROWTH SIMULATION

Simulation of the effects of light intensity and duration on growth and development of green plants. Program available for Apple II, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

PLANT ROOT MODEL

Graphically illustrates the control a root has over the rhizosphere. Available for IBM-PC compatible equipment. WISC-WARE

PLANT STACKS

HyperCard tutorial allows student to view the basic processes and structures as they appear in plants. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

PLANTID

Tutorial introduces identification and taxonomy of woody plants. Available for DEC equipment. THE CLEARINGHOUSE

REALTREE - FRACTAL SIMULATION OF TREE GROWTH

Presents a simple fractal model, capable of drawing a hugh variety of tree-like shapes with variation in a few parameters. Designed as an exercise in an undergraduate Field Biology course. Available for IBM-PC compatible equipment. WISC-WARE

REPRODUCTION IN PLANTS

Tutorial reviewing asexual and sexual reproduction in plants. Program available for Apple II equipment. J & S SOFTWARE

SEXUAL REPRODUCTION IN PLANTS

Tutorial covering plant reproduction including meiosis, gamete formation, reproduction cycles, and alternation of generations. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

SOLAR FOOD

Tutorial/Simulation dealing with photosynthesis. Program available for Apple II equipment. HRM SOFTWARE

THE PLANT - NATURE'S FOOD FACTORY

Tutorial/simulation covering flowers, leaves, stems, roots, and cells. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

CLINICAL MEDICINE

ABG PRACTICE/THE ABG TEACHER

Drill and practice and tutorial programs dealing with acid/base evaluation. Available for Apple II and IBM- PC compatible equipment. MEDSOFT

AHB - ABNORMAL HUMAN BIOLOGY CLINICAL TUTORIALS

Tutorial organized as 12 separate lessons. Program presents a situation requiring a diagnosis and asks what tests the student would perform, providing informational and numerical feedback along the way. Available for IBM-PC compatible equipment. WISC-WARE

ALCOHOL ABUSE AND ALCOHOLISM

Set of eight patient-management problems simulating the treatment of patients with alcohol related problems. Available for Apple II and IBM- PC compatible equipment. UMKC SOFTWARE SERIES

ARRHYTHMIAS: CASE STUDIES IN MANAGEMENT

Simulated patients with various cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

ARRHYTHMIAS TUTORIAL I/ TUTORIAL II

Tutorial dealing with all major cardiac arrhythmias. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

ARTERIAL BLOOD GASES

Tutorial dealing with the interpretation of arterial blood gases. Available for Apple II and IBM- PC compatible equipment. WILLIAMS & WILKINS

ARTERIAL BLOOD GAS ANALYSIS

Tutorial/drill and practice program designed to sharpen clinical skills in assessing blood gas levels. Available for IBM-PC compatible and Macintosh equipment. DECKER ELECTRONIC PUBLISHING

BLANCHAER CLINICAL CASE STUDIES

Eight simulations of clinical syndromes. Program available for IBM compatible and Macintosh equipment. BIOSOFT

BLOOD COUNTS & DIFFERENTIAL EVALUATION – TEACHING MODULE

Test proficiency in the interpretation of blood counts. Available for IBM- PC compatible equipment. LEA & FEBIGER

BLOOD GASES

Tutorial covering blood gas interpretation. Available for IBM-PC compatible, Apple II, and Macintosh equipment. MAD SCIENTIST SOFTWARE

BODY FLUIDS SERIES

Four question banks covering body

fluids, urine physical properties, and urine specimens and formation. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

BUILDING A MEDICAL VOCAB - COURSE

Tutoria/drill covering basic word parts from which medical terms are built. Available for Apple II and IBM-PC compatible equipment.
W.B. SAUNDERS CO.

BUILDING MEDICAL VOCAB - REV COURSE

Tutorial/drill reviewing medical terms. Available for Apple II and IBM-PC compatible equipment.
W.B. SAUNDERS CO.

CARDIOLOGY

Study/review package dealing with various aspects of cardiovascular disease. Available for Apple II and IBM-PC compatible equipment.
UMKC SOFTWARE SERIES

CARDIOPULMONARY RESUSCITATION

Tutorial to help students identify the signs of cardiac arrest, learn the steps to take before beginning CPR, and identify the correct procedure for performing chest compression. SUBSTANCE ABUSE EDUCATION INC

CHEST PAIN: AN EXERCISE IN CLINICAL PROBLEM SOLVING

Patient management problems dealing with chest pain. Available for Apple II and IBM-PC compatible equipment.
WILLIAMS & WILKINS

CLINICAL PATHOLOGY SERIES

Seven questions banks covering basic clinical chemistry, advanced clinical chemistry, blood cell counting, coagulation, hematocrit and hemoglobin, normal differential preparing and reading, and phlebotomy. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

CLINICAL SCIENCES

Self-assessment package covering internal medicine, ob/gyn, pediatrics, preventive medicine and public health, psychiatry, and surgery. Available for Apple II and IBM-PC compatible equipment. UMKC SOFTWARE SERIES

DOSE CALC

Tutorial covering basic math skills and drug dosage calculations. Available for Apple II compatible equipment.
W.B. SAUNDERS CO.

DRUG INTERACTIONS

Computer tool providing access to clinically significant interactions between 600 generic and 1,400 brand-name drugs. Available for IBM-PC compatible equipment.
W.B. SAUNDERS CO.

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

EMERGENCY MEDICAL ENGLISH

Practice and reinforcement program to provide exposure to language data emphasized in emergency medical technician training. Available for IBM-PC compatible equipment. WISC-WARE

EPPIE

Simulation of spatial epidemics allows epidemiology students explore the spread of disease. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

GAS MAN

Simulation of uptake and distribution of inhalation anesthetics in a 70 kg subject. Available for Apple II compatible equipment MEDMAN SIMULATIONS

GASMAN

Simulation dealing with the principles of inhalation gas uptake. Available for Apple II compatible equipment.
ADDISON-WESLEY PUBLISHING CO.

HEMATOLOGY SERIES

Three question banks covering basic hematology, advanced hematology, and hematopoiesis. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

IMMUNOLOGY SERIES

Three question banks covering basic serology, immunohematology, and advanced immunology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

INSTITUTIONAL PATIENT SIMULATION

Simulation designed to develop and enhance medication problem solving skills. Available for IBM-PC compatible equipment. WISC-WARE

INTRODUCTION TO MEDICAL TERMINOLOGY

Tutorial helps students learn basic concepts of medical language. Available for IBM-PC compatible equipment.
SUBSTANCE ABUSE EDUCATION INC

LEARNING CARDIAC ASCULTATION

Tutorial focusing on a broad range of cardiac abnormalities. Available for IBM-PC compatible equipment.
WISC-WARE

MANAGING PATIENTS WITH NEUROLOGICAL PROBLEMS

Simulation of 6 cases providing practice and experience in diagnostic reasoning skills by demonstrating the needs of patients and the effects of nursing intervention. Available for Apple II and IBM-PC compatible equipment. W.B. SAUNDERS CO.

MED-CAPS DIAGNOSTIC PROBLEM SOLVING CASES/MANAGER

Case simulations covering a wide range of clinical problems. The manager consists of a set of programs for monitoring student use and performance on the diagnostic problems. Available for Apple II and IBM-PC compatible equipment. HEALTH SCIENCES CONSORTIUM

MEDICOMP: COMPUTER TUTORIAL SERIES

A series of 16 tutorial designed to help students review various key areas of clinical pathology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MEDILIX

HyperCard stack to help students learn medical language by analyzing prefixes, stems, and suffixes of medical terms. Available for Macintosh equipment. CHARIOT SOFTWARE GROUP

MICROBIOLOGY SERIES

Six question banks covering AIDS, basic microbiology, microbiology case studies, clinical laboratory techniques, clinical bacteriology, and parasites. Available for Macintosh equipment.
INTELLIMATION LIBRARY FOR THE MACINTOSH

PHYSIOLOGICAL TEST DATABASE

Database for Dbase III pluse environment that includes diagnostic information about the use and methodology of 288 tests in clinical chemistry, hematology, immunology, microbiology, physiology and urinalysis. Available for IBM-PC compatible equipment. WISC-WARE

STEDMAN'S MEDICAL DICTIONARY
Tool containing a main dictionary and two supplemental dictionaries. Apple II compatible equipment. SENSIBLE SOFTWARE, INC.

THE SURGEON
Simulation of surgical correction of an aortic aneurysm. Available for Macintosh equipment. INFORMATION SYSTEMS FOR MEDICINE, INC.

CYTOLOGY

CELL CHEMISTRY I
Tutorial covering various chemical structures. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

CELL CHEMISTRY II
Tutorial covering the chemical and physical processes that occur within cells. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

CELLGROW
Simulation of cell kinetics. Program available for Apple II equipment. UNIVERSITY OF TEXAS SYSTEM CANCER CTR

CELL GROWTH AND MITOSIS
Interactive simulation covering surface area-volume ratio, chromosome number, chromosome replication, and cytoplasmic division. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

CELLS
Simulation of experiments in tracking the movement of cells through the four-state mitotic cell cycle. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

CELLS: STRUCTURE AND FUNCTION
Simulation reinforces basic concepts of cell structure, cell functions, water movement and concentration gradients, and diffusion and active transport. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGY

AIR POLLUTION
Simulation of carbon monoxide pollution in an urban environment. Program available for Apple II, IBM-PC compatible and Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

AQUATIC ECOLOGY
Utilities to perform many of the calculations common to aquatic ecology. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

AQUATIC ECOLOGY DATA SIMULATION
25 simulations covering aquatic systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

ECOLOGICAL DATA SIMULATION
25 simulations covering ecological systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

ECOLOGY
Rote drill reviews and reinforces concepts of general terrestrial, and aquatic ecology. Available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

ECOLOGY
Simulation dealing with plant population sizes and growth pattern. Available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGICAL ANALYSIS - PC
Utilities that perform life table analysis, interspecific association indices, community similarity, diversity indices, descriptive statistics, mark-release recapture analysis, plus regression and correlation analysis. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

ECOLOGICAL ANALYSIS VOL. 2 - PC
Utilities that perform community similarity analysis, indices of dispersion, species-area curve, and step-wise multiple regression. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

ECOLOGICAL ANALYSIS PROGRAMS PLUS
Utilities that perform life table analysis, community similarity indices, diversity indices, predator-prey modeling, mark-recapture analysis, descriptive statistics, plus regression and correlation analysis. Program available for Apple II equipment. OAKLEAF SYSTEMS

ECOLOGICAL MODELING
Series of 7 programs dealing with a variety of techniques for modeling ecological systems and processes. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

GREENHAUS
Tutorial designed to acquaint students with the subject areas of energy, environment, and resources. Available for DEC VAX equipment. THE CLEARINGHOUSE

HOTHOUSE PLANET
Simulation that lets students vary the key environmental factors associated with global warming. Available for Apple II, IBM-PC compatible and Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

NICHE-ECOLOGICAL GAME/ SIMULATION
Game in which students attempt to place an organism in its proper ecological niche correctly by specifying environment, range, and competitor. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

POLLUTE
Simulation of factors affecting water quality. Includes temperature, amount and type of pollutant, and water treatment. Program available for Apple II equipment. COMPUWARE

POLLUTE:IMPACT/WATER POLLUTANTS
Simulation of the impact of various pollutants on typical bodies of water. Program available for Apple II and IBM-PC compatible equipment. DIVERSIFIED EDUCATION ENTERPRISES

WATER POLLUTION
Simulation of the effects of temperature, type of waste, dumping rate, and method of treatment on the impact of pollution on aquatic life. Program available for Apple II, IBM-PC compatible an Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

EVOLUTION

DARWIN'S VOYAGE OF THE BEAGLE
HyperCard introduction to the epic world tour of Charles Darwin's HMS Beagle. The presentation immerses students in the sights and events of the tour, along with Darwin's own responses and reactions to his experi-

ences. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

EVOLUT: Evolution and Natural Selection

Simulation of fluctuations in gene frequencies of wild populations. Program available for Apple II equipment. CONDUIT

EVOLUTION

Simulations covering mutation, gene flow, natural selection, and genetic drift on populations. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

EVOLVE

Simulation of evolution using the Hardy-Weinberg formula and the population model that has evolved from its application. Available for Apple II equipment. CONDUIT

SIMULATED EVOLUTION

Simulation using animation to provide a graphic illustration of the origin of biological species by natural selection. Available for IBM-PC compatible equipment. LIFE SCIENCE ASSOCIATES

FORESTRY

CACTOS

Simulation to model the changes that take place in young growth conifer stands in the mixed conifer region of Northern California. Available for IBM-PC or PS/2 compatible equipment (requires Windows). WISC-WARE

GENETICS

A TUTORIAL IN RECOMBINANT DNA TECHNOLOGY

HyperCard tutorial covering recombinant DNA technology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

ADVANCED GENETICS

Tutorial/Simulation presented as a nine-part program covering dominance and recessiveness, partial dominance, lethality, mechanism of inheritance, multiple alleles, sex linkage, multi-trait inheritance, crossing over, and gene mapping. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

BEANS

Simulation to demonstrate the Hardy-Weinberg Principle of gene equilibrium as covered in a first year college course in general biology. Available for IBM-PC or PS/2 compatible equipment. WISC-WARE

BIRDBREED

Simulation providing 16 breeding groups of birds with defined phenotypes for exploring genetic principles. Available for Apple II compatible equipment. EDUTECH, INC.

CATGEN

Simulation allowing students to mate domestic cats of known genotypes. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

CATLAB (Second Edition)

Simulation in introductory genetics. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

CELLS AND GENETICS PICTURE FILE

Hi-Res diagrams of animal cell, plant cell, mitosis, meiosis, Punnett Square, sex linked traits, DNA replication, protozoa, energy reactions, and pedigree. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

DICROSS-DIHYBRID CROSSES

Simulation of various types of dihybrid crosses. Program available for Apple II, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

DNAGEN-DNA/GENETIC CODE SIMULATION

Simulation of genetic code to produce protein sequences. Program available for Apple II and IBM-PC compatible equipment. DIVERSIFIED EDUCATION ENTERPRISES

DNA-THE BASICS

Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple, IBM-PC compatible and Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

DNA - THE MASTER MOLECULE: LEVEL II MUTATIONS AND PROTEIN STRUCTURE

Simulation includes base sequences of two actual genes plus option to enter a custom gene. Mutation by point, addition or deletion can be made to any part of the gene. Available for Apple II, IBM-PC compatible and Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

FARMER

Simulation for use in teaching basic Mendelian genetics. Available for DEC VAX equipment. THE CLEARINGHOUSE

FLYGEN

Simulation of monohybrid or dihybrid crosses with 25 varieties of Drosophila. Program available for Apple II and IBM-PC compatible equipment. DIVERSIFIED EDUCATION ENTERPRISES

GENESIM

Simulations of experminents in bacterial and molecular genetics. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

GENETIC ENGINEERING

Contains two gene base sequences plus an option to enter a custom gene, comparing changes to the normal gene. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

GENETIC ENGINEER'S TOOLBOX

Tutorial introducing the principles and techniques of genetic engineering. Available for Apple II compatible equipment. HRM SOFTWARE

GENETICS

Tutorial/simulation in which the imaginary planet Gensim is a "microworld" in which genetic variation in a native species is determined by patterns of inheritance similar to those of humans. Available for Apple II compatible equipment. AGENCY FOR INSTRUCTIONAL TECHNOLOGY

GENETICS

Tutorial covering various crosses in plants and fruit fly populations. Program available for Apple II and TRS-80 Model III and IV equipment. J & S SOFTWARE

GENETICS

Tutorial that allows students to explore Mendel's experiments, Punnett Squares, sex linkage in fruit flies, and multiple alleles. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

GENETICS

Tutorial examines DNA molecule and

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progresses to applied genetics. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

GENTIC DRIFT

Tutorial-simulation focusing on random changes with time in the distribution of individuals in small populations. Program for Apple II equipment. QUEUE, INC.

HEREDITY DOG

Tutorial covering various genetic topics. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

HUMAN GENETIC DISORDERS

Simulation investigating inherited disorders. Program available for Apple II equipment. HRM SOFTWARE

HYPERFLY SERIES

Two simulations providing an introduction to genetics, the study of monogenic inheritance and and phenotypic ratios. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

INTRODUCTORY GENETICS

Three part tutorial covering a variety of topics. Program available for Apple II and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

KANGASAURS - TRANSMISSION GENETICS

Simulation that provides an open framework for discovering and mastering genetic concepts. Available for Apple II and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

LIFE

Educational game dealing with changing distributions of individuals. Program for Apple II equipment. QUEUE, INC.

LINKOVER: Genetic Mapping

Simulation of genetic mapping experiments. Program available for Apple II equipment. CONDUIT

MACFLY

Simulation of a genetics laboratory complete with breeding fruit flies. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

mDNA

Program provides a tool for exploring different mitochondrial DNA models. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MEIOSIS

Tutorial/Simulation providing an interactive portrayal of gamete formation. Program available for Apple II, IBM-PC compatible and Macintosh equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

MEIOSIS, MITOSIS, PROTEIN SYNTHESIS

Simulation demonstrating mitosis, meiosis, DNA replication, and protein synthesis. Program available for Apple II equipment. SCOTT FORESMAN & CO.

MENDELIAN GENETICS

Simulation covering dominance, partial dominance, lethality, linkage, and sex linkage. Program for Apple II equipment. QUEUE, INC.

MITOSIS AND MEISOSIS

Tutorial demonstrating the processes of mitosis and meiosis as an animal cell progresses through all stages of division. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MONOCROS-MONOHYBRID CROSSES

Simulation of various monohybrid genetic crosses. Program available for Apple II and IBM-PC compatible equipment. DIVERSIFIED EDUCATION ENTERPRISES

NATURAL SELECTION

Tutorial/Simulation dealing with genetics and evolution to populations. Available for Apple II and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPGEN-POPULATION GENETICS

Simulation of the effects of Hardy-Weinberg Law conditions on gene, genotype, and phenotype frequencies of a population over time. Program available for Apple II and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

MICROBIOLOGY

DILUTE-MICROBIAL DILUTION SERIES

Simulation covering design and testing of microbial dilution series to determine concentration of a bacterial solution. Program available for Apple II and IBM-PC compatible equipment. DIVERSIFIED EDUCATION ENTERPRISES

INQUIRER

Database to serve as a resource to supplement information usually acquired through traditional means. Information covers fact, principles, and concepts of pathogenic bacteria, pathogenesis, and infection. Available for DEC VAX equipment. THE CLEARINGHOUSE

MICROBIOLOGY TECHNIQUES

Tutorial/Simulation covering various laboratory procedures. Available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

NEUROSCIENCE

ACTION POTENTIAL TUTORIAL

HyperText-based tutorial dealing with membrane potentials, the voltage clamp, the sodium action potential, refractory periods, and axon conduction. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM

Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

AUTONOMIC SYSTEM

Tutorial on neurophysiology, the parasympathetic system, and the sympathetic system. Available for Macintosh equipment. IRVINE INTERACTIVE INC

AXOVACS

A simulation program that investigates the mechanisms underlying the action potential by graphically fitting the Hodgkin-Huxley equations for single or multiple channels. Available for IBM-PC compatible equipment. AXON INSTRUMENTS, INC.

COCKROACH NERVE CORD

HyperCard lab stack give an extensive description of the classic cockroach nerve preparation and covers principles of extracellular recording, recording from giant axons in the nerve cord, and stimulation of single cercal hairs. Available for Macintosh equipment (requires HyperCard 1.2.2) INTELLIMATION LIBRARY FOR THE MACINTOSH

FROG SCIATIC NERVE

HyperCard stack describes the classic frog sciatic nerve preparation. Covers nerve conduction, conduction velocity, bidirectionality, effects of temperature, and refratory periods. Available for Macintosh equipment (requires HyperCard 1.2.2) INTELLIMATION LIBRARY FOR THE MACINTOSH

HUMAN BRAIN: NEURONS

Tutorial covering neuronal structure, types of neurons, electrical potentials, synaptic transmission, and neurotransmitters. Available for Apple II compatible equipment. BIOSOURCE SOFTWARE

LOLIGO ELECTRONICUS

Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. EDUCE EDUCATION TECHNOLOGIES

MEMBRANE POTENTIAL PROBLEM SOLVER

Simulation to help students grasp the complexities of cell membrane potentials. Available for IBM-PC compatible equipment. TRINITY SOFTWARE

MEMBRANE POTENTIAL TUTORIAL

HyperCard tutorial focusing on the concepts of membrane structure and function. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MEMPOT

A graphical interactive program that simulates the measurement of membrane potentials in a number of excitable cells and allows the fitting of permeability parameters to the data. Available for IBM-PC compatible equipment. BARRY, DR. PETER H.

MODEL NEURON

Simulated experiments demonstrating the dynamic aspects of excitable cell behavior. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

NERVE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NEUROMUSCULAR CONCEPTS

Tutorial covering muscle action potentials, use of electromyograph, contraction, muscle action and movement disorders. Program for Apple II equipment. BIOSOURCE SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for IBM-PC compatible equipment. BIOSOFT

NEURO-SYS

Tutorial that teaches the basics of neuroanatomical techniques that are commonly used to trace nerve fibers and their interconnections. Available for IBM-PC compatible equipment. BIOSOFT

POSTSYNAPTIC POTENTIALS LAB

HyperCard-based laboratory exercise examining properties of chemical synapses using a neuromuscular preparation in a crayfish limb. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

THE CHEMICAL SYNAPSE TUTORIAL

HyperCard-based tutorial that introduces students to the main concepts of chemical synapse. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

THINK TANK

Allows experimental differentiation between chemical synapses, electrical synapses and no synapses. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

NURSING

For an extensive list of educational software for nursing, consult the Directory of Educational Software for Nursing published by the Fuld Institute for Technology in Nursing Education, 28 Station Street, Athens, OH 45701 (614) 592-2511

PHARMACOLOGY

CARDIAC PHARMACOLOGY

Simulation of cardiac activity in response to a variety of pharmacological agents. Available for IBM-PC compatible equipment. WALKER, DR J.R.

CARDIOLAB

Simulation of cardiovascular pharmacology experiments. Available for IBM-PC compatible equipment. BIOSOFT

EFFECTS OF DRUGS ON THE UTERUS AND THE INTESTINE

Simulation of uterine activity and intestinal smooth muscle. Available for IBM-PC compatible equipment. WALKER, DR. J.R..

ILEUM

Simulates laboratory experiments investigating effects of drugs on the *in vitro* guinea pig ileum. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

MACDOPE

Simulation dealing with absorption, distribution, metabolism, and elimination of drugs. Available for IBM-PC compatible equipment. IRL PRESS

MACPHARMACOLOGY

Tutorial/review of various aspects of pharmacology. Available for Macintosh equipment. UNIVERSITY OF MINNESOTA - DULUTH

PHARMACOKINETICS

Simulation for one-compartment and two-compartment models. Available for IBM-PC compatible equipment. COOKE, DR. WILLIAM

PHARMATUTOR

Five short class exercises that include pharmacokinetic simulations, effects of agents on the cardiovascular system, and regulators of smooth muscle function and neuromuscular transmission. Available of Macintosh equipment. FUND FOR RESEARCH IN ALTERNATIVES TOANIMAL EXPERIMENTATION

PRINCIPLES OF PHARMACOLOGY

Tutorial covering history, drug absorption and distribution, biotransformation and elimination, mechanisms of action, and drug safety and efficacy. Program for Apple II equipment. BIOSOURCE SOFTWARE

REGULATION OF THE CARDIOVASCULAR SYSTEM

0742-3233/92/$0.00 + 2.00

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. WALKER, DR. J.R.

RESPIRATROY PHARMACOLOGY

Tutorial/simulation based on pulmonary function data obtained from guinea pig to teach the fundamental pharmacology of the airways. Available for IBM-PC/PS2 Compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

PHYSIOLOGY

ABGAME

Tutorial and game providing practice in acid-base principles. Program available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

ACID-BASE BALANCE

Graphical analysis of Henderson-Hasselbalch equations. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

ACID-BASE PHYSIOLOGY SIMULATION

Simulation of acid-base disturbances based on Davenport Diagram. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

ACID-BASE SIMULATION PROGRAM

Simulation of acid-base disturbances. Values are displayed numerically and in up to five common graphical formats. Designed for use a a lecture aid and for independent study. Available for IBM-PC and PS/2 equipment (requires Windows). WISC-WARE

ARTWAVE: THE RADIAL ARTERY PRESSURE WAVEFORM

Simulation dealing with factors influencing the shape of the radial arterial pressure waveform. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

BALANCE: MYOCARDIAL OXYGEN SUPPLY AND DEMAND

Simulation of the cardiovascular system predicting myocardial oxygen supply and demand. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

BASIC HUMAN

Integrated systems model of human physiology. Program available for IBM-PC compatible equipment. RANDALL, DR. JAMES

BIOFEEDBACK

Part of 10 program package Experiments in Human Physiology. Experiments include biofeedback, conditioning, and perception measurements. Program available for Apple II equipment. HRM SOFTWARE

BIOFEEDBACK MICROLAB

Package includes a pulse rate sensor that measures EMG, a thermistor probe to measure skin temperature, and an interface circuit that enables student to connect the sensors to the computer. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

BLOOD

Simulation to teach the principles of the laboratory determination of red blood cell indicies and blood group. Available for BBC/Master and IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

CALIBRATION

Part of 10 program package Experiments in Human Physiology. Temperature and timing functions are calibrated against standards. Program available for Apple II equipment. HRM SOFTWARE

CAPEXCH

Simulation dealing with exchange at the capillary level. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

CARDIAC MUSCLE MECHANICS

Simulation of heart muscle behavior in response to changes in length, load, and contractility. Available for IBM-PC compatible equipment. QUEUE, INC.

CARDIOCOMP

ECG/EMG data acquisition and analysis system. Available for IBM-PC compatible equipment. INTELITOOL INC.

CARDIOVASCULAR FITNESS LAB

Provides students with everything they need in order to use the microcomputer to monitor cardiovascular activity. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

CARDIOVASCULAR FUNCTION LABORATORY / PHYSIOLOGY LABORATORY TUTOR

Programs developed to provide problem-based learning in cardiovascular physiology. Available for IBM-PC compatible and Macintosh equipment. FROM THE HEART SOFTWARE

CARDIOVASCULAR INTERACTIONS

Cardiovascular Physiology simulation. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

CARDIOVASCULAR PHYSIOLOGY PART I: PRESURE/FLOW RELATIONS

Tutorial dealing with a variety of calculations in the area of hemostatics/hemodynamics. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CARDIOVASCULAR PHYSIOLOGY PART II: REFLEX

Tutorial dealing with carotid sinus regulation of blood pressure, and reflex responses in hemorrhage and exercise. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CIRCSIM: A TEACHING EXERCISE ON BLOOD PRESSURE REGULATION

Simulated experiment based on a model of the baroreceptor reflex loop. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CIRCSYST

Simulation of hemodynamics. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

COLONIC PERISTALSIS

Tutorial/simulation to teach the principles of peristalsis using isolated rat colon. Program describes the nervous control of intestinal longitudinal and circular muscle, the apparatus used to measure longitudinal muscle activity, and propulsion of fluid through the gut. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

COMMON THEMES IN PHYSIOLOGY – CONSERVATION OF MASS

Simulations/problems applying conservation of mass principles to physiological situations. Included are indicator dilution experiments and mass balance experiments. Available for IBM-PC compatible equipment. NRCLSE

COMMON THEMES IN PHYSIOLOGY – OSMOTIC PRESSURE RELATIONSHIPS

Tutorial format using simulated experiments covering determinants of osmotic pressure, cell reactions to osmotic environments, and fluid movement at the capillary. Available for IBM-PC compatible equipment. NRCLSE

CONCEPTS IN THERMOGRAPHY

Tutorial covering basic DC concepts, peripheral vascular physiology, detecting skin temperature, amplifiers, and processing DC signals. Program for Apple II equipment. BIOSOURCE SOFTWARE

CRAB ION BALANCE

HyperCard stack describing the effects of blood sodium levels in crabs bathed in water with different salinities. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

CRAYFISH MEMBRANE POTENTIAL LAB

Hypercard program designed to guide students through the laboratory exercise of measuring resting membrane potentials in crayfish muscle fibers. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

DIGESTION

Tutorial covering digestion in simple organisms and humans. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

EFFECT OF SIZE ON MOUSE METABOLISM

HyperCard stack describing the effects of mouse size on the metabolic rate. With the use of simple metabolic chambers, experiments are performed on mice of different sizes. Available for Macintosh equipment (requires HyperCard1.2.2). INTELLEMATION LIBRARY FOR THE MACINTOSH

ENDOLAB

An endocrine physiology computer laboratory designed to provide some experience with the effects of a number of hormones as well as practice in problem-solving in endocrinology. Available for IBM-PC compatible equipment. DIETZ, DR. JOHN R.

ENDOCRINE SYSTEM

Tutorial covering hormones, effects and problems. Program available for Apple II equipment. J & S SOFTWARE

EXCRETION

Tutorial reviewing metabolic wastes, waste removal, and kidney function. Program available for Apple II equipment. J & S SOFTWARE

EXERCISE EXPERIMENTS

Part of 10 program package Experiments in Human Physiology. The effect of exercise and physical condition on heart rate, breathing rate, and skin temperature is investigated. Program available for Apple II equipment. HRM SOFTWARE

EXERCISE PHYSIOLOGY

Simulation of some of the important physiological measurements that can be made to assess cardio-respiratory performance of "fitness" in the laboratory. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

FLEXICOMP

Data acquisition and analysis system for studying the reflex arc. Available for Apple II and IBM-PC compatible equipment. INTELITOOL, INC.

FROG GASTROCNEMIOUS MUSCLE

HyperCard stack describing the classic frog gastrocnemius muscle preparation. Covers the muscle twitch, stimulus-response relationships, work fone, summation, and tetanus. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

FROG HEART

Simulation of experiments that can be performed on the *in situ* frog heart. Available for IBM-PC compatible and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

FROG HEART

HyperCard stack describing the classic frog heart preparation. Covers heart contraction, temperature effects, adrenaline, and acetylcholine effects, and the refractory period of the ventricle. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

FROG SKIN - MEMBRANE TRANSPORT

Simulation of experiments that can be performed on the frog skin preparation to teach the principles of the epithelial transport of ions. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

GAS DIFFUSION IN THE LUNG

Simulation of oxygen and CO2 transfer between alveolar air and blood. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

GASP: A TEACHING EXERCISE ON THE CHEMICAL CONTROL OF VENTILATION

Simulated experiment based on a nodel of the chemical control of ventilation (MACPUF). Available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

GLOMERULAR FILTRATION, CONCENTRATION-DILUTION, Tm

Package of three renal physiology teaching programs. Available for IBM-PC compatible equipment. DIETZ, DR. JOHN R.

GUINEA PIG ILEUM

Simulation of the isolated, transmurally stimulated guinea pig ileum preparation to investigate the effects of drugs on neurotransmitter release in the enteric nervous system. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

HEART RATE

Part of 10 program package Experiments in Human Physiology. Light and light sensor for measuring and recording heart rate. Program available for Apple II equipment. HRM SOFTWARE

HOMEOSTASIS-THERMOREGULATION

Part of 10 program package Experiments in Human Physiology. Students investigate the body's ability to maintain a constant internal temperature by subjecting a volunteer to mild temperature excursion while recording and displaying skin and body temperature. Program available for Apple II equipment. HRM SOFTWARE

HUMAN BODY-STRUCTURE AND

FUNCTION

Simulation covering joint movement, movement of food through digestive system, and enzyme activity. Program available for Apple II equipment. SCOTT, FORESMAN & COMPANY

HUMAN CIRCULATORY SYSTEM

High resolution pictorial simulation. Available for Apple //c (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

HUMAN ELECTROCARDIOGRAM

HyperCard stack describes the classic human ECG (response, artifacts, heart sounds, exercise effects) and finger pulse (dicrotic notch, exercise effects, temperature effects). Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

HUMAN LUNG

HyperCard stack allowing students to record breathing movements and the corresponding electrocardiogram. The experiments include the effect of gravity on lung capacity and of rebreathing on breathing. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

HUMAN SEXUALITY

700 questions test item bank dealing with the anatomy/physiology of human reproductive system. Available for DEC VAX equipment. THE CLEARINGHOUSE

INTESTINAL ABSORBTION

Simulated experiments designed to demonstrate the important characteristics of the transport of hexoses and amino acids in the small intestine. Available for IBM-PC/PS2 compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

LOLIGO ELECTRONICUS

Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. EDUCE EDUCATION TECHNOLOGIES

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

MACMAN

Simulation of circulatory system. Available for IBM-PC compatible equipment. IRL PRESS

MACPEE

Simulation of interactions of renal physiology. Available for and IBM-PC compatible equipment. IRL PRESS

MACPUF

Simulation of cardiopulmonary physiology. Available for IBM-PC compatible equipment. IRL PRESS

MECHANICAL PROPERTIES OF ACTIVE MUSCLE

Set of six programs concerned with skeletal muscle contraction. Available for IBM-PC compatible equipment. QUEUE, INC; TRINITY SOFTWARE

MEMBRANE POTENTIAL TUTORIAL

HyperCard stack tutorial that explores membrane structure and permeability. the Donnan equilibrium, the Na/K/ATPase pump, the Nernst equation, and the Goldman equation. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

MOUSE THYROID GLAND

HyperCard stack describes the effects of reversal thyroid destruction on growth rate and cold temperature on the metabolic rate. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

MUSCLE MECHANICS: A COMPUTER-SIMULATED EXPERIMENT

Simulated experiment that permits the user to determine either the length-tension or the force-velocity relationship of a skeletal muscle. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

MUSCLE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve-gastrocnemius muscle to illustrate some of the physiological properties of skeletal muscle. Available for IBM-PC compatible and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NERVE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NERVOUS SYSTEM

Tutorial covering nerves, reflexes, and chemical transfer of impulses. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. BIOSOFT

O_2/CO_2 TRANSPORT MODEL

Simulation for studying oxygen transport from the lungs to the tissues. Available for Apple II and IBM-PC compatible equipment. GAAR, DR KERMIT

PHYSIOLOGICAL DATA SIMULATION

25 simulations covering aspects of physiology. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

PHYSIOLOGICAL SIMULATION PROGRAM

The basic purpose of this program is to provide interactive software that can be used in a variety of physiological simulations applicable for biomedical teaching and research. Available for IBM-PC or PS/2 equipment (requires Windows 2.03). WISC-WARE

POSTSYNAPTIC POTENTIALS IN CRAB STRETCHER MUSCLE

Tutorial/Simulation of neuromuscular preparations in a crab limb to illustrate the properties of chemical synapses. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

PROBLEMS IN FLUID COMPARTMENT RE-DISTRIBUTION

Tutorial covering solution of simple problems of fluid compartment changes in the face of perturbations. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

PSIMPLE

Twenty-five problem sets, each containing between 4 and 15 problems. Areas covered include cardiovascular, respiratory, and renal physiology. Available for Macintosh equipment. MINES, DR ALLAN H.

PSYCHOLOGICAL STRESS-LIE DETECTOR

Part of 10 program package Experiments in Human Physiology. The physiological response to the stress of a frustrating and abusive quiz is measured. Program available for Apple II equipment. HRM SOFTWARE

PULMONARY MECHANICS

Tutorial and simulation dealing with pulmonary mechanics. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. WALKER, DR J. R.

PERMEABILITY

Simulation of osmotic phenomena in cells. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

PHYSIOGRIP

Data acquisition and analysis system for the muscle physiology lab. Available for Apple II and IBM-PC compitble equipment. INTELITOOL, INC.

RENAL GLOMERULAR DYNAMICS

Simulation of human glomerulus and factors that affect glomerular filtration rate. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

RESPIRATION RATE

Part of 10 program package Experiments in Human Physiology. A napping subject is monitored for heart and breathing rate. Results are compared to the data acquired when the subject is awake. Program available for Apple II equipment. HRM SOFTWARE

RESPONSE-TIME

Part of 10 program package Experiments in Human Physiology. Users measure finger reaction times with a bright light stimulus (sensor included). Program available for Apple II equipment. HRM SOFTWARE

RESPONSE-TIME INVESTIGATIONS

Part of a 10 program package Experiments in Human Physiology. The effects on reaction times of stimulus type and response location are studied. Program available for Apple II equipment. HRM SOFTWARE

RESPSYST, GASEXCH

Simulations dealing with pulmonary gas exchange. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

SIMULATED EXERCISE PHYSIOLOGY LABORATORIES

Simulations of 20 common equations used in exercise physiology. Available for Apple II and IBM-PC compatible equipment. HUMAN KINETICS PUBLISHERS

SIMULATIONS IN PHYSIOLOGY - THE RESPIRATORY SYSTEM

Series of 12 simulations dealing with respiratory mechanics, gas exchange, chemoregulation and acid-base balance. Program available for Apple II, IBM-PC compatible, and Macintosh equipment. NRCLSE

SKELETAL MUSCLE ANATOMY/ PHYSIOLOGY

Tutorial covering three muscle categories, skeletal muscle microstructure, sliding filament theory, motor units, and lever systems. Program for Apple II equipment. BIOSOURCE SOFTWARE

SKELETAL MUSCLE CONTRACTIONS

Tutorial/Simulation of muscle mechanics. Available for IBM-PC compatible equipment. SIEGMAN, DR. MARION J.

SKILLS IN ELECTROMYOGRAPHY

Tutorial covering skin preparation, reducing EMG artifact, testing a myograph's operation, electrode location, and preventing shock hazards. Program for Apple II equipment. BIOSOURCE SOFTWARE

SKIN TEMPERATURE

Part of a 10 program package Experiments in Human Physiology. Temperature probe (included) senses body and skin temperatures. Program available for Apple II equipment. HRM SOFTWARE

SPIROCOMP

Data acquisition and analysis system for measuring lung volumes and capacities. Available for Apple II and IBM-PC compatible equipment. INTELITOOL, INC.

THE AUTONOMIC SYSTEM

Tutorial on neurophysiology, the parasympathetic system and the sympathetic system. Available for Macintosh equipment. IRVINE INTERACTIVE INC.

THE CARDIAC CYCLE

HyperCard stack providing students with three animations for viewing the cardiac cycle: a four-chamber echocardiographic sequence, a Wiggers' plot of physiologicaly variables, and a pressure-volume diagram of the left ventricle. Available for Macintosh equipoment. GOERKE, DR. JON

THE CARDIAC VECTOR

HyperCard stack examining how hyocardial electrical events generate the frontal vectorcardiogram and the standard limb leads of the electrocardiogram. Available for Macintosh equipment. GOERKE, DR. JON

THE CARDIOVASCULAR SYSTEM

Tutorial on hemodynamics, peripheral circulation, the heart, and integration. Available for Macintosh equipment. IRVINE INTERACTIVE INC

THE ELECTROCARDIOGRAM

Interactive, menu-driven program to teach the fundamentals of the electrocardiogram. Available for IBM-PC compatible and BBC B/Master equipment. SHEFFIELD BIOSCIENCE PROGRAMS

THE EINTHOVEN TRIANGLE

HyperCard stack that allows students to explore how changes in the direction and magnitude of the cardiac net dipole vector affect voltages in the standard electrocardiographic leads. Available for Macintosh equipment. GOERKE, DR. JON

THE ENGINE OF LIFE

An animated tutorial about the human heart. Available for IBM-PC compatible equipment. P11 ENTERPRISES

THE LANGENDORFF HEART

Simulated experiments that can be performed on the isolated perfused mammalian heart (Langendorff preparation). Available for IBM-PC compatible equipment. SHEFFIELD BIOLSCIENCE PROGRAMS

THE MUSCLE TUTORIAL

HyperCard tutorial covering striated muscle structure and physiology. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE

0742-3233/92/$0.00 + 2.00

MACINTOSH

THE RAT UTERUS SMOOTH MUSCLE LAB

HyperCard-based laboratory exercise that uses rat uterus smooth muscle to study the effect of muscle length and weight on the amount of contraction. Available for Macintosh equipment. INTELLIMATION LIBRARY FOR THE MACINTOSH

THE VISUAL SYSTEM

Tutorial/Simulation covering visual components, visual pathways, visual defects and deficiences, and eye movement. Available for IBM-PC compatible equipment. LIFE SCIENCE ASSOCIATES

TITRATION

Graphical analysis of buffers. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

VENTROL

Tutorial and simulation dealing the the regulation of breathing. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

WATER AND ION MOVEMENT ACROSS FROG SKIN

HyperCard stack describes the effects of ouabain and antidiuretic hormone on the movement of sodium and water across frog skin. Available for Macintosh equipment (requires HyperCard 1.2.2). INTELLIMATION LIBRARY FOR THE MACINTOSH

POPULATION DYNAMICS

BALANCE-PREDATOR-PREY SIMULATION

Simulation of the effects of food supply, carrying capacity, environmental conditions, and external pressures or predator/prey relationships. Program available for Apple II, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

COEXIST:Population Dynamics

Simulation of the growth of two populations either independently or in competition for the same limited resources. Program available for Apple II equipment. CONDUIT

COMMUNITY DYNAMICS

Tutorial/simulation dealing with interaction of predator and prey systems. Available for Apple //e equipment. EDUCATION MATERIALS & EQUIPMENT CO.

ISLAND BIOGEOGRAPHY

Three simulations of island communities dealing with the relationship between island area and number of species, colonization of a new island, and island immigration and extinction. Program available for Apple II equipment. CONDUIT

LIMITS

Simulation of the effects of growth on world population, pollution, food supply, industrial output, and natural resources. Program available for Apple II equipment. COMPUWARE

MARK & RECAPTURE

Simulation of mark and recapture experiments to explore three models for estimating population sizes. Program available for Apple II equipment. CONDUIT

POP

Simulation of three growth models (exponential, logistical, and logistical with low density). Program available for Apple II equipment. COMPUWARE

POPGRO-POPULATION GROWTH SIMULATION

Simulation of unlimited growth (J-curve), limited growth (S-curve) and limited growth with response lag time (S-curve with oscillations) models of population growth. Program available for Apple II, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

POPULATE

Designed as a supplement to courses for first-year biology science majors. It is intended as a preview of material to be presented in lecture. Available for DEC VAX equipment. THE CLEARINGHOUSE

POPULATION CONCEPTS

Simulation dealing with factors influencing population growth. Available for Apple //e equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPULATION FLUCTUATIONS

Tutorial covering factors influencing population growth. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPULATION GROWTH

Simulation dealing with exponential and density-dependent gowth. Program for Apple II equipment. QUEUE, INC.

POPULATION GROWTH

Simulation of population growth. The package compares and contrasts the geometric or exponential growth model with the logistic or Verhulst-Pearl growth model. Program available for Apple II equipment. CONDUIT

POPULATON SIZES

Simulation dealing with a dynamic population. Program for Apple II equipment. QUEUE, INC.

PREDATION

Simulation of predator-prey interactions. Program available for Apple II equipment. CONDUIT

PREDATION EQUILIBRIA

Simulations of equilibrium models of predator-prey interaction. Program available for Apple II equipment. CONDUIT

ZOOLOGY

ZOOLOGY I

Tutorial covering the general charactistics, structures, and functions that define the major invertebrate phyla. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

ZOOLOGY II

Tutorial covering physiology in the Phylum Chordata. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

MISCELLANEOUS

BAFFLES, BAFFLES II

Game to help students develop deductive reasoning and problem solving skills. Program available for Apple II (BAFFLES) and IBM-PC compatible (BAFFLES II) equipment. CONDUIT

BASIC SCIENCES

Self-assessment package covering anatomy, behavioral science, biochemistry, microbiology, pathology, pharmacology, and physiology. Available for IBM- PC compatible equipment. UMKC SOFTWARE SERIES

CLASSIFY-CLASSIFICATION KEY PROGRAM

Presents an unclassified set of characteristics and labels for classification at various levels. Program available for Apple II and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GRADE KEEPER - PC

Grade book manager that handles classes up to 300 students, up to 25 grades per student. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

GRADEBK

Program for the analysis of a large set of grades. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

LABPLOT

Allows the Apple II with any A/D converter card to be used as a multipen chart recorder or as an X/Y plotter. BIOSOFT

LIFE TABLES AND THE LESLIE MATRIX

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 25

COMPUTER PROGRAM FOR MEMORY TESTS 26
Inez Sipinkova and Jozef Zahumensky

WHERE ARE THE VIDEODISCS? 29

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a regular feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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COMPUTER PROGRAM FOR MEMORY TESTS

Inez Sipinkova and Jozef Zahumensky

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The human physiology curriculum at the Medical Faculty of the Comenius University in Bratislava consists of 24 individual courses, each lasting 3-4 hours. One of the courses is dedicated to higher functions of the nervous system and, in the past, was based predominantly on teaching the classical Pavlovian physiology of conditioned and unconditioned reflexes with corresponding demonstrations in experimental animals. Due to the need to reduce the number of experimental animals used in physiology classes, we faced the problem of a new design for our course on higher neural functions.

Learning, memory, judgment, and language are complex phenomena related to higher functions of the nervous system.[2] Because of the complexity and limited knowledge of the nature of these central nervous functions (resulting in a rather complicated presentation in most of the textbooks), many medical students often consider this part of human physiology difficult to understand and learn.

In order to make the course more attractive, we decided to make memory the primary topic of the course and created the computer teaching program described in this article.

PROGRAM OVERVIEW

The computer program was written in TurboPascal 6.0 and compiled. It may be run on IBM-AT compatible computers with EGA graphics. The program is fully menu driven with all text and instructions appearing in windows. In order to organize the program and focus student attention, a color scheme was adopted to identify the function of various parts of the written text (eg, instructions for use appear in red, information on program options in black, etc).

At the beginning of the program, the student may identify himself by giving his name which then appears on all graphic outputs of the results on the screen or printer. The student proceeds by choosing to run either the recent memory test section of the program or the tutorial on memory.

MEMORY TESTS

The recent memory tests section of the program includes the following four tests.

- Visual memory recall for meaningful works
- Visual memory recall test for meaningless words
- Auditory memory recall test for meaningful words
- Visual memory recognition test for meaningful words

Visual memory recall test for meaningful words

Fifteen different meaningful one or two syllable words are chosen at random from a store of 300 words and displayed for 25 seconds. The student is then prompted to type the words he has remembered. The words may be typed in an arbitrary order and if a word is repeated, the successive inputs are neglected. The input words appear on the screen in two columns labeled as "Correct" and "Incorrect". When all recalled words have been entered, the student initiates evaluation of the test by pressing the "Esc" key. The evaluation is presented as a short comment that depends on the percentage of words retained. A graphic presentation of the results is also possible. A bar graph of the memory test results can be displayed on the screen and also be printed (Figure 1). The number of memory tests performed by each individual is not limited, but only the last five of them can be displayed graphically.

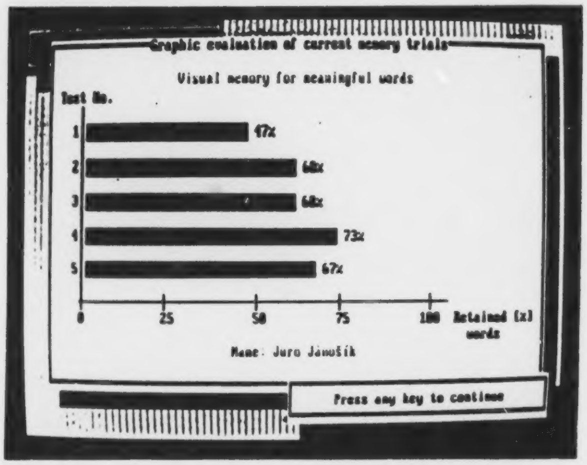
Graphic evaluation of current memory trials
Visual memory for meaningful words
Test No.
1
2
3
4
5
47%
60%
60%
73%
67%
0
25
50
75
100
Retained (%) words
Name: Juro Janošík
Press any key to continue

FIGURE 1. Example of a graphic representation of the results from a visual memory recall test for meaningful words.

Visual memory recall test for meaningless words

The principle of operation of this memory test is similar to that of the previous test. Fifteen meaningless, one syllable words are selected at random and presented on the screen for 25 seconds. The input of the recalled words, the screen display, and the graphic presentation of the results is essentially the same as in the previously described test. The comment on the achieved memory score is adjusted to the higher demands posed by remembering meaningless words and thus to lower percentage of words retained.

Auditory memory recall test for meaningful words

In this memory test, fifteen meaningful words of up to two syllables are selected at random by the computer from the same word store used for the visual test for meaningful words. These are displayed on the screen for an unlimited period of time. The tested person is seated facing away from the computer, and the displayed words are read aloud in the displayed order by a second student. Each word is read only once. After the test words have been read aloud, the screen is cleared by pressing any key. The tested student turns to the computer and inputs all the words he is able to retrieve. The input, the screen display, and the graphical design is similar to the two former tests.

Visual memory recognition test for meaningful words

Fifteen different randomly selected meaningful words of unlimited syllable count are displayed on the screen for 25 seconds. Afterwards, these presented words are mixed in a random order with fifteen other words that were not displayed. All thirty words are then displayed on the screen one by one, and the recognition of the formerly shown words is tested. The student is requested to answer whether the currently displayed verbal item was or was not among the fifteen words he was to remember. During the recognition phase of the test, the count of correctly and incorrectly recognized (ie, false positive) words as well as the total count of the words is displayed on the screen.

In the Memory Tests section of the program, the choice of the test is completely voluntary, and any type of the test may be skipped. Results of all memory tests performed are stored in the computer memory, so the student can change the type of memory test being run and return to a previous one with the former memory scores remembered. If desired, the student may also consult the Tutorial on Memory section during his memory trials, and his individual scores are not lost.

TUTORIAL ON MEMORY

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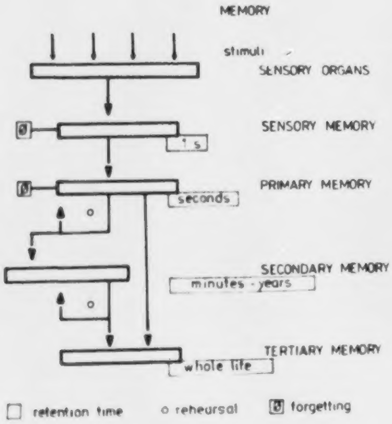

FIGURE 2. Schematic drawing of the structure of memory used in the "Tutorial on memory."

The tutorial on memory presents a schematic drawing of the structure of memory on the screen (Figure 2). The drawing is a modification of a scheme presented by Silbernagl and Despopoulos.[5] In this scheme, the functional and time relationships between several parts of memory (eg, primary, secondary memory) are presented. Individual parts of memory are defined on the basis of the stability of memory traces. In addition, the role of rehearsal and forgetting and the retention time of the encoded memory traces are displayed.

This scheme also serves as a menu. By pressing the highlighted letters in the terms MEMORY, SENSORY ORGANS, SENSORY MEMORY, PRIMARY MEMORY, SECONDARY MEMORY, or TERTIARY MEMORY, the student can get detailed information on the chosen topic.

USE OF THE PROGRAM

The program was welcomed by both medical students and members of the teaching staff. The program is neither a typical "tutorial" nor a typical "simulation"[3] and can not be regarded as problem-based learning.[4] It is much more a tool in the hands of a skillful teacher, who can enhance the framework of memory presented by the program with further information. The computer program gives him the best aid for teaching: students' attraction by the topic.

By testing his own memory capacities, the student becomes involved in the matter. It is well observed that student interest in learning is enhanced in cases when the material is regarded as relevant to his own person (eg, interest in diseases on suffers from) or applicable to his future career (eg, hints on clinical application of theoretical knowledge). The computer program gives the teacher the opportunity to act not as the dominator but as the facilitator of teaching.[1]

The teacher may demonstrate the differences between iconic (visual) and echoic (auditory) memory and show several factors influencing learning, encoding, and retrieval of memory traces. By means of memory tests with meaningful and meaningless words, the importance of semantic coding in addition to acoustic coding can be explained, and the influence of phonological and semantic associations on acquisition of meaningless stimuli can be presented. Further, the primacy and recency effects (ie, higher retention level of words presented at the beginning and at the end of the word list to be remembered) may be observed mainly by the auditory memory recall test. Visual memory recall tests may be used to illustrate the effect of location of a word on the screen as a retrieval cue (ie, remembering by a method of loci). Recognizing previously encountered words in the recognition memory test may be used to explain the differences between the processes of retrieval and recognition and confirm the higher scores in recognition memory tests compared with recall ones.

The computer program was designed primarily for use with undergraduate students and therefore only the simple memory scores were chosen to assess the memory functions. The performance on the tests does not necessarily imply the quality of everyday memory functioning,[6] and it has to be stressed that the memory scores of those students who are not familiar with computers may be artificially reduced. Work with the keyboard may accelerate forgetting or act as a deconcentration factor. It is also the role of the teacher to explain that memory does not involve only remembering of words but also of nonverbal items (color, patterns, etc.).

CONCLUSION

The computer program for short-term memory tests was used in a course on higher functions of the nervous system. The program helps the physiology teacher explain the complex functions of the central nervous system and activates the students during the course. In our experience, use of the program results in more students asking questions concerning the topic and inquiring about references for additional study.

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WHERE ARE THE VIDEODISCS?

Applications of interactive video in life science education continues to grow. As the cost of the technology necessary to implement interactive video falls within the feasibility range of institutions and the interest in Hypermedia continues to grow, more educators are looking for sources of video images or interactive video courseware to use in their teaching efforts. Perhaps the best resource for learning what videodisc material is available on the market is *The Videodisc Compendium for Education and Training* published by Emerging Technologies Consultants, Inc. The videodisc information that follows was drawn from that publication. Each entry in our listing includes the title, a *brief* overview of the content, the vendor, and the vendor's telephone number. The *Compendium* contains a more detailed description of the material. For information concerning the *Compendium* or for assistance in locating appropriate videodisc material, contact Richard Pollak, Emerging Technology Consultants, Inc., P.O. Box 12444, St. Paul, MN 55112, telephone: (612) 639-3973.

ANATOMY AND PHYSIOLOGY

ANATOMY AND PHYSIOLOGY OF THE HEART 24 modules covering various aspects of normal and abnormal cardiac anatomy and physiology. *Compatible with:* IBM InfoWindow *Vendor:* British Columbia Institute of Technology (604) 432-8761

CARDIOVASCULAR LAB SIMULATION Simulation of experiments in cardiovascular physiology. Covers experimental preparation, autonomic control, cardiac catheterization, positive pressure ventilation, fibrillation, manometer experiments, the normal and abnormal cardiac cycle, and euthanasia. *Compatible with:* IBM InfoWindow or Matrox VGO-AT overlay board; Pioneer LD-V4200 or LD-V6000 *Vendor:* Dr. Charles Branch, Auburn University (205) 844-5414

CIRCULATION OF THE BLOOD/KIDNEY FUNCTIONS Two-part program examines the circulatory system and the functioning of the kidneys. In part 1, animation examines the actions of the heart, shows how matter is exchanged in cells, and illustrates the nervous system's role in regulating heartbeat. In part 2, microphotography shows how blood vessels network in the kidneys extracts waste material from the body. *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

HISTOLOGY, A PHOTOGRAPHIC ATLAS 7000 original color micrographs of cells, tissues and organs focus on mammalian and human histology. *Compatible with:* Any player *Vendor:* Image Premastering (800) 848-4912 X2348 (612) 644-7802

HUMAN BODY: SYSTEMS WORKING TOGETHER Uses graphically-designed animated diagrams to explain (with microphotography and x-ray pictures) the interactions among the body's systems. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

HUMAN BRAIN ANIMATIONS A collection of computerized 3-D reconstructions of the human brain. Allows user to view structures from all angles and in proximity to other structures. *Compatible with:* Any player *Vendor:* University of Washington (206) 685-1186

MEDIQUIZ: GROSS ANATOMY Uses game show format as a knowledge assessment tool in medical school gross anatomy course. Divides 5 major regions of the body: Back and upper limb, thorax, abdomen and pelvis, perineum and inferior extremity and head and neck into 5 categories each. User chooses 5 categories from any region or combination of regions and also chooses review material. Two rounds of questions, a spelling round, and a challenging final round questions make up 1 game of Mediquiz. *Compatible with:* Sony VIEW 5000, Matrox, EIDS, IBM PC or compatible with Online Corporation's GLG-512 board and Pioneer LDV-6000 *Vendor:* Henry M. Jackson Foundation (301) 295-6700

THE HUMAN ANATOMY: ABDOMEN AND PELVIS Demonstrates musculoskeletal anatomy of the abdomen and pelvis using embalmed specimens and archival footage of the abdominal contents in an unembalmed cadaver. Live model shows corresponding functional surface anatomy. *Compatible with:* Any player *Vendor:* Teaching Films (800) 421-2363 (708) 328-6700

THE HUMAN ANATOMY: HEAD AND NECK Examines key structures controlling the entry of air and food into the body including: paranasal sinuses, maintenance of an open airway in an unconscious person, the relationship of the eustachian tube to the middle ear, and the role of the larynx, tongue and epiglottis in swallowing. *Compatible with:* Any player *Vendor:* Teaching Films (800) 421-2363 (708) 328-6700

THE HUMAN ANATOMY: LOWER EXTREMITY Surveys musculoskeletal anatomy of the back, pelvic girdle and lower extremity and demonstrates the appropriate joints and muscles with emphasis on functional anatomy. Live model displays corresponding surface anatomy. *Compatible with:* Any player *Vendor:* Teaching Films (800) 421-2363 (708) 328-6700

THE HUMAN ANATOMY: NEUROANATOMY Introduces the anatomy of the brain and spinal cord showing cortex, medulla, basal ganglia, and some connecting pathways. Outlines brain coverings, ventricles and blood supply. *Compatible with:* Any player *Vendor:* Teaching Films (800) 421-2363 (708) 328-6700

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The Human Anatomy: Thorax Demonstrates the mechanical basis for respiration with emphasis on cooperation of the chest wall, lungs and heart in delivering oxygen to the body. Contrasts lungs in an embalmed specimen with a fresh lung. Shows main features of the heart, including film footage of a functioning aortic valve and cineangiography. *Compatible with:* Any player *Vendor:* Teaching Films (800) 421-2363 (708) 328-6700

The Human Anatomy: Upper Extremity Surveys musculoskeletal anatomy of the shoulder girdle and upper extremity and demonstrates the appropriate joints and muscles with emphasis on functional anatomy. Live model displays corresponding surface anatomy. *Compatible with:* Any player *Vendor:* Teaching Films (800) 421-2363 (708) 328-6700

The Human Digestive System Shows how the human digestive system works using endoscopic pictures, diagrams, photomicrographs and lab experiments. *Compatible with:* Any player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

The Living Textbook - The Frog Contains slides and movie clips covering all basic concepts in the anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Mammalian Heart/Lungs Explains structure and function of the mammalian heart by using the hearts of a sheep and dog. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 773-4300

Regulating Body Temperature/Digestive System Deals with temperature regulation in vertebrates and the mechanical and chemical processes of digestion. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862

Work of the Heart/Muscles: Structure and Function Animated footage illustrates the parts of the heart and how they relate to the work of the lungs, arteries and veins. Muscle portion deals with the three types of muscles. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862

BIOLOGY - GENERAL

A World Alive An all-animal cast stars in this wildlife documentary. The diversity of the animal kingdom and the habits and habitats of giraffes, fish, wolves, birds, and more will excite and even amuse. Feeding, mating, running and playing, the animals offer an eloquent plea to preserve, conserve and admire nature's wonders. *Compatible with:* HyperCard 2.1; any RS-232 player *Vendor:* Voyager Company (800) 446-2001 (213) 451-1383

Bio Sci II Almost 8000 still photos, including 100 movie sequences with narration, 500 computer graphics and 30 animations of cell anatomy and protein synthesis. Demonstrates use of compound microscope. Full dissections of the earthworm, crayfish, sea star, perch, frog, fetal pig, and cat muscles in labeled and unlabeled quiz format. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Developmental Biology: Patterns in Green Introduces students to the 3 repeating geometric patterns to which virtually all plant leaves and flowers conform: spirals, zig-zag, and whorled. Shows that plant phyllotaxy is probably related to evolution, discover the "ulterior motives" lurking behind leaf and petal phyllotaxy, and discern which biological mechanism causes almost every plant to group its appendages in one of three common patterns. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Developmental Biology: Projecting Visions Broad overview of problems involved in nerve regeneration and the latest research and methodology in this area. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Developmental Biology: Shaping Up Covers developmental processes of morphogenesis – body pattern formation and maintenance of shape. Asks which mechanisms allow cells to construct and maintain the form of the adult organism. Experiments and studies involving various organisms for study of cell migration, regeneration and cell division; polarity of regeneration; and the body-patterning roles of epithelial cells, neurons, and morphogens. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Developmental Biology: What You Never Knew About Sex Program looks at different species that can use one, two or even more mechanisms to create a balances supply of male and female individuals. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Evolution: Inquiries into Biology and Earth Science A complete curriculum package illustrating processes of organic and physical changes through time, highlighted by evolutional themes. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Insects From the Smithsonian Laserdisc Collection. Demonstrates the stunning ways insects have evolved and adapted to survive for eons while so many other animals have become extinct, and why scientists consider insects to be the most successful living organisms on earth. *Compatible with:* Any player *Vendor:* Lumivision (800) 748-1776 (303) 860-0400

Lifetimes of Change: Development and Growth Uses human, animal and plant life examples to cover birth, growth, change, and decay. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 773-4300

Nature View 4600 full color images of worldwide species of scientifically identified plants and animals (2700 plants, 1130 butterflies, 880 chordates). Common names and survey text included for many species. *Compatible with:* Any player *Vendor:* Bio Libe Associates (708) 546-3350

Nature: Rain Forest Selva Verde: The Green Jungle A first-hand look at the jungles and wildlife of Central America. *Compatible with:* Any player *Vendor:* Image Entertainment (818) 407-9100

Relationships Covers relationships among organisms including parasites, colonies, social insects, predators, prey and competition. *Compatible with:* Any player *Vendor:* Syscon Corp (804) 486-2656

Reproduction in Organisms 3-part program covering egg laying and hatching in turtles, snails, insects, and a nudibranch; explains sexual forms of reproduction; and explains asexual reproduction. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 773-4300

Supersense: Making Sense Do animals think in some human sense of the word, or are they total instinctive creatures? Examines this age-old question. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Supersense: Seeing Sense Explains how and what animals see. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Supersense: Sense of Timing Nature is full of uncanny examples of rhythmic cycle of live. Shows that animal timing is very much controlled by precision-made internal clocks, timepieces set by the rhythms of a natural world, but whose organic mechanisms are not yet well understood. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Supersense: Sixth Sense Human beings perceive the world through the five senses of sight, sound, smell, taste and touch. A sixth, or extra sense of perception has long been suspected and conjectured about, yet substantive proof has not been established. Points out that in animals, a sixth sense is much more verifiable. Because animals do not possess a large, human-like brain, most compensate with at least one heightened sense. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Supersense: Sound Sense A great many land, sea and flying animals have hearing, sound-producing abilities far exceeding what most would ever imagine. Because so much animal sound cannot be detected by the human ear, many animal communication secrets have been unknown until fairly recently. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Supersense: Super Scents Explores how the sense of smell can govern the habits and strongly influence the ability of individuals and species to maintain their niche in complex ecosystems. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

The Biology Encyclopedia Shows thousands of still images representing organisms from every major phylum. Illustrates major genetic, anatomical, developmental, and biochemical processes. Full-motion sequences show real-life examples. Includes HyperCard stack and teacher's guidebook. *Compatible with:* Macintosh; any RS-232 player *Vendor:* Carolina Biological Supply (800) 334-5551 (919) 226-6000

The Bio Libe Encyclopedia Contains 6000 color frames of over 5000 plant and animal species accessible by Genus species names. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (800) 848-4912 X2348 (612) 644-7802

The Living Reef Explores the composition of the Great Barrier Reef and looks at many types of marine life that live on and around the coral islands. *Compatible with:* Any player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

The Living Textbook - Animal Behavior Based on the Encyclopedia of Animals videodisc series, reviews more than 700 species of mammals, birds, reptiles, fish, invertebrates and insects. Image directory provides description of each visual in print, diskette and CD-ROM formats. *Compatible with:* Apple IIGS, Macintosh; Pioneer LD-V2200 *Vendor:* Optical Data Corp (800) 524-2481 (908) 668-0022

The Living Textbook - Life Science Contains more than 2,700 slides and 164 movie clips covering all basic concepts in life science/biology taught at the secondary and college levels. *Compatible with:* Apple IIGS or Macintosh; Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Living Textbook - Mechanisms of Stability and Change Over 2,000 slides and 47 movie clips. Thematically explores natural processes in physiology, genetics, ecology and evolution which govern stability and change. Image directory provides description of each visual, and transcript of each narrated movie clip in print, diskette and CD-ROM formats. (Bilingual: English/Spanish) *Compatible with:* Apple IIGS, Macintosh; Pioneer LD-V2200 *Vendor:* Optical Data Corp (800) 524-2481 (908) 668-0022

The Miracle of Life Records the first second of human conception, then follows the complex developments that culminate in the birth of a newborn

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baby. Close-ups and magnifications up to half a million times. *Compatible with:* Any player *Vendor:* Voyager Company (800) 446-2001 (213) 451-1383

Videodisc in Science Education Four units of instructional materials included on the disc, suitable for use in most introductory high school and college biology courses. *Compatible with:* Any player *Vendor:* Waterford Institute (801) 373-2009

BIOTECHNOLOGY

Biotechnology: Learning the Techniques Step-by-step presentations of 33 standard laboratory protocols. *Compatible with:* Any player *Vendor:* GPN (800) 228-4630 (402) 472-2007

BOTANY

Encyclopedia of Landscape Plants Photos from 6 universities, with 7400 views of 900 species/varieties of cultivated woody plants: full foliage, fall color, winter form, young plant, leaf detail, leaf bud, bark, branching pattern, canopy, trunk flair, flower bud, flower and fruit. Includes 400 images of plant disorders, including some common natural and man-made problems. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Exotic Plants: A Videodisc Compendium Contains over 2,000 high quality color photographs of tropical, subtropical and other exotic plants. *Compatible with:* Any player *Vendor:* VT Productions (408) 438-3100

Living Trees/The Living Soil Defines and describes the parts and functions of trees. Illustrates the forces that create the soil and the many organisms that use and enrich it. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 773-4300

Pollination Biology Documentary dealing with all facets of flower pollination. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Photosynthesis 3-D computer animation shows the historic discoveries of Joseph Priestly, Jan Ingenhousz, and Jean Senebier. Examines the absorption of light by plants and other organic materials. Demonstrates the Calvin cycle as it functions in carbon 3 and carbon 4 plants and the fluid transport system that delivers water and nutrients throughout the plant structure. *Compatible with:* Any player *Vendor:* TV Ontario (800) 331-9566 (919) 967-8004

CELL BIOLOGY

Cell Biology: Living Cell/Nucleus Examines cell specialization in relation to the function it performs for an organism. Introduces the structure and function of the nucleus and details the DNA molecule and protein synthesis, DNA replication prior to mitosis, and mitosis and cell division. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Cell Biology: Motion and Function of the Living Cell Includes film sequences and still images covering cell types, cell constituents, mitosis and cytokinesis, fission and cell motility. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Cell Biology: Plasma Membrane/Cytoplasm Shows processes of diffusion, osmosis, active transport, and endocytosis as means of transferring molecules to and from cells through the membrane, providing needed chemical reactions, maintaining a stable interior environment, and allowing electronic signals to be passed to other cells. Light and electron microscopic examinations of cytoplasmic functions of plant cells, animal cells and protists show how the cytoplasm acquires building-block molecules, converts them into fuel to make new cell structures and products. Explains protein assembly process and coded genetic instructions. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Cellular Respiration Uses computer animation to examine the essential fuels and machinery used by living forms to sustain themselves. Examines the connection between the processes of cellular respiration and nutrition. *Compatible with:* Any player *Vendor:* TV Ontario (800) 331-9566 (919) 967-8004

Living Cells Spectacular microphotography reveals vigorous activities of both single-celled and multicellular organisms. Time-lapse photography follows the internal movements in cells of green algae, plant hair and onions. *Compatible with:* Any player *Vendor:* Aims Media (800) 367-2467 (818)773-4300

Meiosis/Mitosis Microscopic footage and animation dealing with the processes of meiosis and mitosis. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

CLINICAL MEDICINE

Abdominal Stab Wounds Simulation designed to teach the initial assessment process. *Compatible with:* IBM InfoWindow, Sony, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

Active Knee Series A library of programs examining the diagnosis of knee injuries by any person who is first to respond. *Compatible with:* IBM InfoWindow *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Adult Airway Management Evaluates mastery of specific objectives relating to adult airway management including: anatomy and physiology, artificial airways, airway adjuncts, goals of airway management, selection and use of artificial airways, complications, clinical simulations, glossary and view records. *Compatible with:* IBM InfoWindow, Sony VIEW, Visage, FITNE, Matrox *Vendor:* Datastar Educational Systems (403) 463-3327

AMERICAN HEART ASSOCIATION: AIRWAY MANAGEMENT Basic non-invasive and specialized invasive procedures of airway management. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

AMERICAN HEART ASSOCIATION: ARRHYTHMIA RECOGNITION Material from American Heart Association ACLS text, ECG lessons, ECG static and dynamic examples. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

AMERICAN HEART ASSOCIATION: CARDIOPULMONARY RESUSCITATION Teaches and tests in CPR and Basic Life Support *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

AMERICAN HEART ASSOCIATION: MEGACODE Trains individuals in organizing and managing cardiac emergencies through simulations. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

AN INTRODUCTION TO CARDIOVASCULAR EXAMINATION Offers learners the opportunity to auscultate a patient's chest, hear actual heart sounds and view dynamic images of a variety of cardiovascular conditions. *Compatible with:* FITNE system or IBM InfoWindow *Venmdor:* Fuld Institute for Technology in Nursing Education (614) 592-2511

A PATIENT WITH DIARRHEA AND VOMITING Presents a patient in the emergency department with flu-like complaints of vomiting and diarrhea. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

ASSESSMENT OF NEUROMOTOR DYSFUNCTION IN INFANTS Covers the 5 parameters of assessment to determine if infants up to 18 months old are normal or have a neuromotor abnormality. *Compatible with:* IBM PC with color monitor, Macintosh; Pioneer LD-V4200, V6000 *Vendor:* Cognitive Design Technologies (319) 337-8109

AUSCULTATION OF NORMAL BREATH SOUNDS/CHEST TUBE THERAPY Reviews standard procedures to auscultate the posterior and anterior chest, patient positions, breathing techniques and stethoscope placement. It also reviews intrathoracic dynamics and the physical dynamics of chest tubes. *Compatible with:* IBM InfoWindow, Sony, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

BASIC LIFE SUPPORT - ADULT SIMULATION designed as preparation and practice for certification in CPR, combining drama and instruction to guide through one and two person CPR, using a mask and foreign body airway obstruction. *Compatible with:* IBM InfoWindow, M-Motion, Sony VIEW 5000, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

BASIC LIFE SUPPORT - INFANT SIMULATION designed for both lay people and health care providers seeking CPR certification. *Compatible with:* IBM InfoWindow, M-Motion, Sony VIEW 5000, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

BASIC OPTHALMOLOGY Covers ocular anatomy, eye examination, assessment of visual loss and glaucoma. Designed for medical students, onoophthalmic physicians, nurses or paramedical personnel. *Compatible with:* IBM PS/2; InfoWindow or M-Motion; any RS-232 player *Vendor:* Educational Resources Group (319) 335-6547

CARDIOVASCULAR RESOURCES VIDEODISC Contains a large collection of materials that may be used to teach cardiovascular nursing and medicine. *Compatible with:* Any player *Vendor:* University of Washington (206) 685-1186

CENTRAL VENOUS PRESSURE/ANTISHOCK TROUSERS Defines the CVP manometer and its 4 functions. Defines the purpose and components of Antishock Trousers. *Compatible with:* IBM InfoWindow, Sony, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

CHEST TRAUMA Presents a patient with respiratory distress and hypovolemic shock resulting from multiple injuries sustained in a car accident. *Compatible with:* IBM InfoWindow, Sony, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

COMMUNICATION CHALLENGES IN NURSING: ESTABLISHING RAPPORT AND TRUST First program in a series teaching communication skills facilitating the nursing process in a patient-care setting. *Compatible with:* IBM InfoWindow, M-Motion, Sony VIEW 5000, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

CYANOTIC PREMATURE BABIES Presents 5 cases of premature, cyanotic infants in respiratory distress at the moment of, or soon after, delivery. *Compatible with:* Any player *Vendor:* Health Sciences Consortium (919) 942-8731

DIAGNOSTIC DECISIONS IN A PATIENT IN SHOCK Presents a challenge in differential diagnosis of emergency department patient with general early complaints that progress to suggest upper gastrointestinal bleeding and/or acute myocardial infarction. *Compatible with:* IBM InfoWindow, Sony, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

DYSRHYTHMIA RECOGNITION Provides basic information to approach dysrhythmia recognition in an algorithmic manner and to determine the site or origin of normal and abnormal rhythms. Includes basic physiology and electrical activity of the heart together with electrode placement and their relationship to the electrical impulses measured. *Compatible with:* IBM InfoWindow, M-Motion, Sony VIEW 5000, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619)456-3577

DYSRHYTHMIA TRAINING AND EVALUATION Designed to train students in electrocardiography with a focus on dysrhythmia recognition. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

EMERGENCY Simulation designed for paramedics, emergency medical technicians, emergency physicians, nurses, and others with a background in emergency training. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Datastar Educational Systems (403)463-3327

EMERGENCY SURGICAL PROCEDURES Two modules on how to perform emergency cricothrotomy and thoracotomy. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

ETHICAL DILEMMAS AND LEGAL ISSUES IN CARE OF THE ELDERLY A case study simulation focusing on 4 ethical situations and their legal implications: advance directives, use of restraints, reassignment of a nurse, and do not resuscitate orders. *Compatible with:* IBM InfoWindow or compatible *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

HEALTHCARE FOR OLDER ADULTS Complete overview of issues and research related to aging. Designed for students, faculty, and practicing nurses and as continuing education for health care professionals in geriatrics and nursing homes. *Compatible with:* IBM InfoWindow, SonyVIEW, FITNE *Vendor:* Univ of Texas Medical Branch (800) 342-4681 (409) 772-1510

INITIAL ASSESSMENT OF RESPIRATORY DIFFICULTY Presents a patient involved in a motor vehicle accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

INTRAVENOUS THERAPY Teaches intravenous therapy principles and techniques. *Compatible with:* FITNE Interactive System or IBM InfoWindow *Vendor:* Fuld Institute for Technology in Nursing Education (614) 592-2511

IV THERAPY/IV SOLUTIONS Reviews overall goals of IV therapy and the major types of IV solutions. *Compatible with:* IBM InfoWindow; any player *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

MANAGING THE EXPERIENCE OF LABOR AND DELIVERY Simulates normal labor and delivery process beginning with admittance to the hospital of the laboring patient and her husband. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

MECHANICAL VENTILATORS Provides brief overview of 10 mechanical ventilators Compatible with: IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox Vendor: Datastar Educational Systems (403) 463-3327

MEDICATION ADMINISTRATION: MODULE I Tutorials providing guidance for administration of oral meds, eye and ear drops, pastes, ointments and creasms including special consideration for pediatric and geriatric patients. *Compatible with:* IBM InfoWindow or compatible *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

MOTOR VEHICLE TRAUMA Simulation takes place in an emergency department, beginning with admission of a multiple trauma patient in hypovolemic shock. *Compatible with:* IBM InfoWindow; any player *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

NURSING CARE OF ELDERLY PATIENTS WITH ACUTE CARDIAC DISORDERS Simulation of a 73 year old with an MI and treated with thrombolytic therapy who develops ventricular fibrillation, and an 80 year old with CHF who develops atrial fibrillation. *Compatible with:* IBM InfoWindow or compatible *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

NURSING OF THE CANCER PATIENT WITH COMPROMISED IMMUNITY: THE NURSING PROCESS Simulates the five steps in the nursing process. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

NURSING CARE OF THE ELDERLY PATIENT WITH COPD A case study simulation about a 73-year old man with COPD and pneumonia. *Compatible with:* IBM InfoWindow, FITNE, Sony VIEW, Visage *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

NURSING DECISIONS: A POSTOPERATIVE PATIENT Simulation that presents 4 postoperative situations common to choecystectomy patients. *Compatible with:* FITNE system or IBM InfoWindow *Vendor:* Fuld Institute for Technology in Nursing Education (614) 592-2511

NURSING DIAGNOSIS #2 Simulations designed to enable students to practice making nursing diagnoses. *Compatible with:* IBM InfoWindow, M-Motion, Sony VIEW 5000, EIDS, FITNE *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

PEDIATRIC PROCEDURES: MODULE 1 Presents 3 related pediatric nursing porcedures. Also appropriate for in-

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hospital technicians and medical students. Topics include: lumbar puncture, bone marrow aspiration, and central line placement. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Resuscitation Adjuncts and Automated External Resuscitation (AHA) Contains all core material from American Heart Association ACLS textbook, plus quizzes, reference banks and both the "A" and "B" version of the written post test. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics (800) 851-3780 (412) 231-6200

SETS: Volumetric Devices Patient-centered simulations of recently developed nursing equipment related to I.V. administration of fluids and drugs. *Compatible with:* IBM InforWindow, M-Motion, Sony VIEW, VAL, Visage, Videologic *Vendor:* SETS (800) 422-7387 (301) 977-2222

Shotgun Wounds to the Abdomen Presents opportunity to assess and manage a patient with shotgun wounds to the abdomen. *Compatible with:* IBM InfoWindow; any player *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

Sterile Technique at the Bedside Instructs health-care professionals in the steps for preparing and applying dressings and maintaining sterile techniques in patient care. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (403) 256-1100

Therapeutic Communication Designed to teach therapeutic communication skills to nursing students and other professionals in the health care field. *Compatible with:* FITNE, IBM InfoWindows *Vendor:* Fuld Institute for Technology in Nursing Education (614) 592-2511

The Small Intestine and Appendix Adapted from Chapter 16 of the "Surgical Textbook" developed by the Association for Surgical Education. Deals with the small intestine, appendix, and acute appendicitis. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Transposition of the Great Arteries Adapted from classic articles on the Jatane Operation. Includes graphic illustrations and a menu accessed interactive video of the operation. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Urinary Catheterization Instructs health-care professionals in the preparation of the patient and the tray and proper catheterization techniques. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (403) 256-1100

USP DI Visualized - About Your Diabetes Provides individualized, custom information to help diabetes patients learn more about their disease. *Compatible with:* IBM PS/2 model 55 and any compatible CD-ROM or any RS-232 player *Vendor:* U.S. Pharmacopeial Convention (800) 227-8772 (301) 881-0666

ECOLOGY

Rain Forest The tropical rain forests of the world are home to nearly half the animal species on earth – an estimated 5 million different life forms. More than 100 inches of rainfall each year sustain this lush environment, where some of the most fascinating examples of natural adaptation can be found. Fascinating and thought-provoking film of the rain forests of Costa Rica that provides an eloquent warning of the natural wonders we stand to lose on a world scale if human encroachment of the world's rain forests continues. (National Geographic) *Compatible with:* Any player *Vendor:* Image Entertainment (818) 407-9100

Survivors: Eagle's Story Looks through the eyes of a family of bald eagles, including a newly-hatched chick. As it grows, learns and developes independence, viewers come to know how human encroachment threatens the survival of all eagles. Show how scientists gather information on these rare creatures, become aware of the fragility of their natural environment, and begin to recognize the enormity of the task of protecting wildlife and wilderness. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Survivors: The Mahogany Connections The odds against a tiny mahogany tree seedling reaching adulthood are enormous. Even if the tree withstands a host of natural dangers – it may be imperiled by civilization. Vivid images present this tree's environment and predicament. See how human activities both protect and jeopardize the mahogany, while developing a greater compassion for species facing extinction. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Survivors: The Mystery of the Million Seals Why is the fur seal population declining? Find an answer as biologist Roger Gentry tracks migration of a herd off southern California to an Alaskan breeding ground. Journey underwater and on land with a female fur seal. Watch her migrate thousands of miles to repeat a ritual of breeding, birth, socializing and childrearing that is becomine more and more hazardous. See a scientist collecting evidence and form a better understanding of the consequences of human activities. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

Survivors: Roo's Eye View Show the world of a baby red kangaroo leaving mother's pouch to explore new surroundings: a national park in New South Wales. As explorations bring contact with other animals, and then civilization, viewers discover why the kangaroo is struggling for survival. Get a broad sense of what life is like for plants, animals and humans in the Australian outback, and learn how the kangaroo is uniquely adapted to exist in these extreme conditions. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

SURVIVORS: SEAGULL STORY What is it like to be a seagull? What is it like to migrate, acquire food from natural and human sources, survive in a world becoming less hospitable to animals? Shows black-backed gulls taken in Britain, Portugal and North Africa provide an enlightening answer to these questions and more! Take a bird's-eye view, witnessing how they interact with varous environments, how they breed and raise their yound, what they eat and why they can live in a wide ranges of habitats. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

SURVIVORS: TALE OF A PLAGUE Discover developmental stages of locusts, including unique physical attributes. Demonstrates where locusts fit in the food chain, how human beings have ironically contributed to the infestation, and the many weapons used to combat them. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

SURVIVORS: THE WOLF SAGA Through the imaginary eyes of a male wolf, and with the help of trackers, the lives of a fragile handful of survivors are recreated. Documents the slaughter of wolves in Sweden and other places. As this story unforlds, you'll get a better understanding of wolves, realize that they present little or no danger to humans, and see why irrational fear and hatred has caused them to be hunted to near extinction. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

DENTAL HEALTH CARE

DENTAL DIAGNOSIS AND TREATMENT: A VIDEODISC ATLAS Represents all oral and dental health care disciplines. Includes dental anatomy, endodontics, family dentistry, oral diagnosis, oral medicine, oral pathology, oral and maxillofacial surgery, orthodontics, pediatric dentistry, periodontics and preventive and community dentistry. *Compatible with:* Any player *Vendor:* University of Iowa (319) 335-9656

GENETICS

GENETICS: PATTERNS OF DEVELOPMENT Shows patterns of gene action during earliest stages of development of frog and fruit fly embryos. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

GENETICS: PATTERNS OF DIVERSITY Deals with the question of whether evolution is associated with random molecular drift or individual proteins in an organism or a response to changes in environment. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

GENETICS: PATTERNS OF EVOLUTION Illustrates modern evolutionary biology, looking at the interplay between organisms and their environment. Highlights field studies on this dynamic interaction. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

GENETICS: PATTERNS OF INHERITANCE Using basic rules of genetics, Dr. John Turner of the University of Leeds shows how he has been able to trace ancestry of a South American butterfly. *Compatible with:* Any player *Vendor:* Coronet/MTI (800) 621-2131 (708) 940-1260

HEALTH SCIENCE

AIDS - AN EDUCATIONAL PROGRAM Provides the essential facts about AIDS and how to avoid contracting the disease. *Compatible with:* IBM InfoWindow *Vendor:* Edutech Support Services (612) 476-1880

THE BIRTH DISC A visual database with over 9,000 images of childbirth from hospitals, birth centers, and home environments. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (800) 848-4912 X2348 (612) 644-7802

INFECTION CONTROL Provides basic information on how an infection is transmitted, how to isolate an infection, and how to prevent an infection from spreading. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems; Online GL512, VAL *Vendor:* Edutech Support Services (612)476-1880

MDR SHARED DISC: RESOURCES III Generic medical images from 8 institutions covering microanatomy, histology, radiology, cardiology, immunology, pathology, neuroanatomy, rheumatology, endoscopy, dermatology, clinical microscopy, nuclear medicine and histology. *Compatible with:* Any player *Vendor:* Stewart Publishing (703) 354-8155

PROCARE: HOW TO BE A NURSE ASSISTANT Designed to help prepare nurse assistants in long term care facilities to meed federal and state requirements for certification. *Compatible with:* IHN Pro-Vision System *Vendor:* Interactive Health Network (404) 850-1000

SLICE OF LIFE III Over 26,000 still images drawn from various areas of medicine, dentistry and allied health education. *Compatible with:* IBM, Macintosh; Any player *Vendor:* Slice of Life (801) 581-8694

SLICE OF LIFE IV A visual encyclopedia of more than 32,000 still images pertaining to medicine, nursing, dentistry, and allied health education. Subjects include cardiology, cytology, embryology, gross anatomy, histology, microbiology, neuroanatomy, parasitology, pathology, radiology, and other clinical disciplines. Side 2 contains dental education, normal range of motion for all major joints, and gait sequences. *Compatible with:* IBM, Macintosh, and RS-232 player *Vendor:* Slice of Life (801) 581-8694

SLICE OF LIFE V A visual database of over 34,000 medical images pertaining to histology, pathology, neuroanatomy, radiology, cardiology, oral pathology, hematology, dermatology, parasitology, cytology, embryology, gross anatomy, opthalmology, microbiology and other clinical disciplines. Designed to repurpose as needed in various instructional programs. Side 2 contains "A Slice of Life in Review: 1990", a 60 minute introduction to the applications of Slice of Life and related medical software. *Compatible with:* Any player *Vendor:* Slice of Life (801) 581-8694

STD: SEXUALLY TRANSMITTED DISEASES INFORMATION PROGRAM Provides the facts about the eight most common sexually transmitted diseases. *Compatible with:* IBM InfoWindow *Vendor:* Edutech Support Services (612) 476-1880

UNDERSTANDING AGING This training program responds to the need for understanding the older population. The course takes a comprehensive look at the physical, mental, social, and work/financial changes that accompany aging. *Compatible with:* IHN Pro-Vision System *Vendor:* Interactive Health Network (404) 850-1000

HEMATOLOGY

BASIC HEMATOLOGY Tutorial, drill and practice, and simulation program that utilizes the "Medical Applications Videodisc: Hematology 2ndEd. (University of Washington) *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Datastar Educational Systems (403)463-3327

INTRODUCTION TO CASE STUDIES IN HEMATOLOGY A series of 20 case studies designed to acquaint students with basic problem-solving techniques involving cell identification and clinical correlations. *Compatible with:* Macintosh; Pioneer or Sony player *Vendor:* Edudisc, Inc (615) 373-2506

LABORATORY MEDICINE VIDEO LIBRARY: ATLAS OF HEMATOLOGY Contains over 6,000 images forming a comprehensive library of hematologic findings which can be used for education, testing and reference. *Compatible with:* Any player *Vendor:* University of Washington (206) 685-1186

MEDICAL APPLICATIONS VIDEODISC: HEMATOLOGY, 2ND EDITION Contains the entire American Society of Hematology morphology collection, the World Health Organization International Histologic Classification of Tumors, frames from the Western Universities' Physical Diagnosis Slide Bank, and extensive morphological study of acute leukemias, and the film "Red Cell Shapes" *Compatible with:* Any player *Vendor:* University of Washington (206) 685-1186

THE HEMATOLOGY VIDEODISC: 1991 A new collection of images containing the American Society of Hematology Slide Bank, 3rd Edition; The University of Tennessee Hematology Collection; a comprehensive selection of images from the University of Washington's Atlas of Hematology videodisc; and selected graphics from the Clinical Diagnosis and Management of Anemia series. *Compatible with:* Any player *Vendor:* University of Washington (206) 685-1186

MICROBIOLOGY

MICROBES: BACTERIA AND FUNGI Examines the physical characteristics, the risky and beneficial applications, and ways to impede and prevent growth of microbes. *Compatible with:* Any player *Vendor:* AIMS Media (800) 367-2467 (818) 773-4300

VIRUSES: WHAT THEY ARE AND HOW THEY WORK/BACTERIA Explores the structure, reproduction and lifestyles of these sometimes harmful but often beneficial organisms. *Compatible with:* Any Player *Vendor:* Encyclopaedia Britannica Ed. Corp. (800) 554-9862

PATHOLOGY AND PATHOPHYSIOLOGY

ACUTE LEUKEMIA MORPHOLOGY II Contains numerous exemplary peripheral blood smears, bone marrows and special stains for instruction and reference in the differentiation of acute leukemias. *Compatible with:* Any player *Vendor:* University of Washington (206) 685-1186

BONE PATHOLOGY Covers 70 bone diseases, including 1900 pictures. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

BREAST PATHOLOGY Provides information about 77 breast diseases, including 1300 disease slides and 900 feature slides. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

CARDIOLOGY SERIES A 12 disc course designed to develop in a logical way the consequences following the creation or establishment of heart defects. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Datastar Educational Systems (403) 463-3327

DISORDERS OF THE NERVOUS SYSTEM: MENTATION Six patients are shown who demonstrate a variety of disorders of mentation. *Compatible with:*

Any player *Vendor:* University of Washington (206) 685-1186

DISORDERS OF THE NERVOUS SYSTEM: MOTOR A compilation of material from a "visual glossary" collection of neurological dysfunction. *Compatible with:* Any player*Vendor:* University of Washington (206) 685-1186

INTERNATIONAL VETERINARY PATHOLOGY SLIDE BANK (5TH ED) Contains still frames of lesions from domestic, laboratory and wild animals from contributors in the U.S., Canada, and Europe. *Compatible with:* IBM-PC; Pioneer LDV-4200 *Vendor:* University of Georgia (404) 542-5837

LARYNX PATHOLOGY Provides information on 50 diseases, including approximately 1500 videodisc images. Performs differential diagnosis with detailed explanations. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

LYMPH NODE PATHOLOGY Provides information on 63 diseases, including approximately 5,000 pictures. Performs differential diagnosis with detailed explanations. Automatically generates surgical pathology report. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

PATHOLOGY OF THE EYE A complete course on opthalmic pathology for advanced medical students, opthalmology residents and fellows and opthalmic practitioners. Covers 12 topics: basic concepts, surgical procefures and non-surgical trauma, cornea, conjunctiva, eyelid, intraocular tumors, retina/vitreous, phakomatoses, congenital anomalies, lens, orbit and optic nerve. *Compatible with:* IBM PS/2; InfoWindow or M-Motion; any RS-232 player (Macintosh version also available) *Vendor:* Educational Resources Group (319) 335-6547

PATHOPHYSIOLOGY OF SHOCK/PATHOPHYSIOLOGY OF CARDIAC TAMPONADE Looks at physiologic effects of shock and the body's compensatory responses to the syndrome. Provides 3 cases that demonstrate how cardiac tamponade presents itself and when to suspect tamponade. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Darox Interactive (800) 733-1010 (619) 456-3577

SELECTED CASES IN GENERAL AND SYSTEMIC PATHOLOGY Presents 54 cases with photomicrographs, radiographs, gross pathology and clinical photographs from American Registry of Pathology. Includes common and uncommon lesions pathologists and pathology residents encounter. *Compatible with:* Any player *Vendor:* Image Premastering (800) 848-4912 X2348 (612) 644-7802

SKIN/PIGMENTED PATHOLOGY Provides information on 51 diseases, includes 4000 images. Performs differential diagnosis with detailed explanations. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

SMALL-INTESTINE PATHOLOGY Provides information on 73 diseases, including approximately 5000 videodisc images. Performs probabilistic differential diagnosis with detailed explanations. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

STOMACH PATHOLOGY Covers 54 diseases of the stomach with 1200 pictures. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

THE URINARY SEDIMENT 1700 high quality photographs and photomicrographs of urinary sediment in disease. Designed as reference source for technologists/pathologists in routine hospital laboratory and training maual for schools of medical technologists and residency programs in clinical pathology. *Compatible with:* Any Player *Vendor:* Image Premastering (800) 848-4912 X2348 (612) 644-7802

THYMUS-MEDIASTINUM PATHOLOGY Covers 46 Thymus-Mediastinal diseases using 1000 pictures. Performs differential diagnosis with detailed explanations. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

THYROID CYTOLOGY Contains 400 pictures on 18 diseases. Allows customized lectures for teaching and conference purposes. *Compatible with:* IBM InfoWindow *Vendor:* Intellipath (213) 453-4596

RADIOLOGY

ACR BREAST IMAGING LEARNING FILE Features over 200 cases with patient histories and pertinent clinical information. Detailed descriptions of radiological findings cover important aspects of mammography and other breast imaging modalities. *Compatible with:* Any player *Vendor:* American College of Radiology (800) 227-5463 X8989 (703) 648-8989

ACR CHEST LEARNING FILE Revised chest section from the ACR Learning File. Contains 312 cases in 8 subsections: basic principles; diffuse pulmonary disease; segmental lobar disease; solitary nodules; cavities; free fluid/air; cardiovascular disorders; mediastinal masses. Includes imaging techniques like magnetic resonance, nuclear medicine and computed tomography. *Compatible with:* Any player *Vendor:* American College of Radiology (800) 227-5463 X8989 (703) 648-8989

ACR GASTROINTESTINAL LEARNING FILE Contains 230 cases in 8 subsections: abdominal plain film; pharynx; esophagus; stomach and duodenum; small bowel; colon and rectum; biliary tract; liver, spleen and pancreas. *Compatible with:* Any player *Vendor:* American College of Radiology (800) 227-5463 X8989

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(703) 648-8989

ACR Pediatric Learning File Revised pediatric section contains 275 cases in 7 subsections: newborn chest; chest; skeletal; gastrointestinal; genitourinary; neurology; cardiovascular. Includes investigative techniques such as: MRI, ultrasound, CT, nuclear medicine, general diagnostics and special procedures with their applications to pediatric conditions. *Compatible with:* Any player *Vendor:* American College of Radiology (800) 227-5463 X8989 (703) 648-8989

An Interactive Approach to Radiographic Anatomy and Positioning Introductory course for radiologic technology students on terminology, basic radiographic anatomy, patient positioning, equipment setup and evaluation criteria. *Compatible with:* Any player; RS-232 player optional *Vendor:* Image Premastering (800) 848-4912 X2348 (612) 644-7802

Recognizing Radiographic Artifacts Allows users to view many x-rays which have unwanted features or artifacts on them and teaches how to recognize these artifacts on the x-rays. Intended for medical students and health care professionals. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

SUBSTANCE ABUSE

Alcohol and Human Physiology Explains the effects of alcohol on human body's major organs and systems. Demonstrates ill-effects of alcohol on the digestive, circulatory, muscular, skeletal, urogenital, and nervous systems, and interviews 6 recovering alcoholics who briefly explain the damage to their bodies from alcohol. *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Cocaine and Human Physiology Documents damage done to the body when cocaine is snorted, injected, or smoked. Explains damage to organs. Describes physical causes of cocaine-induced death and grave effects on infants of pregnant users. (Bilingual: English/Spanish) *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Designer Drugs and Human Physiology: Crack, Cocaine, Methamphetamine Traces unpredicable capabilities of "crack" and "speed," from physical damage to complete interruption of a normal lifestyle. Weighs ill-effects including emphysema and cerebral hemorrhaging against fleeting moments of enjoyment. Recovering addicts warn of the permanent harm caused by the substances. *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Designer Drugs and Human Physiology: PCP, Ecstasy, Fentanyl Explains that PCP, Ecstasy and Fentanyl are concentrated synthetics illegally formulated in clandestine laboratories for enormous profit. Shows devastating effects of these substances on the body's cardiovascular and neurological systems. Sets viewers straight on personal dangers posed by these compounds. *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Heroin and Human Physiology Presents statistics on heroin use in the U.S. Describes the devastating effects of heroin on the body, including infections and abscesses, inflammation of the lymph glands, swelling of the hands, and tetanus. Illustrates how the drug inflicts its greatest damage on the brain, lungs, and heart. Discusses the effects of heroin on an unborn child. Warns against sharing drug needles and shows some of the diseases contracted by people with AIDS. (Bilingual: English/Spanish) *Compatible with:* Any Playe*Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Marijuana and Human Physiology Uses hard facts about marijuana and its effects on the body to dispel belief that the drug offers harmless recreation. Describes damaging effects on sinuses, pharynx, uvula, lungs, heart, brain, reproductive system and immune system. Discusses development of the "pot personality," hazards of driving while under the influence, and dangers of mixing marijuana with alcohol. (Bilingual: English/Spanish) *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Marijuana and the Mind Reports current research into effects of marijuana on the brain. Shows mental changes sustained by users through laboratory demonstrations, interviews with physicians and other health care professionals, and documented experiences of recovering addicts. Describes warning signs of addiction. *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

Tobacco and Human Physiology Explains the physiological effects of tobacco on human bodies. Covers smoked and smokeless tobacco. Shows how human respiratory system works and is damaged by the particulate matter in cigarette smoke. Describes diseases caused by smoking including emphysema, cancer and heart attacks and looks at tobacco's effect on an unborn child. *Compatible with:* Any Player *Vendor:* Aims Media (800) 367-2467 (818) 773-4300

WILDLIFE MANAGEMENT

Yellowstone in Winter Provides insight into the work of Yellowstone's rangers in their management of wildlife. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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CONTENTS

KEEPING ABREAST OF THE LITERATURE 41

CURRENT ISSUES IN SELECTING A DATA ACQUISITION SYSTEM 43
Philip S. James and Dennis Robinson

NRCLSE 1992 COLLEAGUE DIRECTORY 47

NRCLSE READER SURVEY 63

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a regular feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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CURRENT ISSUES IN SELECTING A DATA ACQUISITION SYSTEM

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Soon after personal computers became affordable, multifunction data acquisition boards began to become common place in the laboratory. There are now well over thirty different data acquisition hardware and software companies, and most claim to have the best product for your application. The best data acquisition should be based on your particular project requirements. Typically you must collect numerous catalogs and scrutinize the specifications to pick the card and software that best meet your needs. This is fine if you have a lot of time and patience. But most of us would like to find the cheapest solution for the least time and effort.

The purpose of this article is to cover the basic elements involved in selecting IBM PC/PS2 or Macintosh data acquisition hardware and software so that your search can a little easier.

ANALOG INPUTS

For most scientists the conversion of analog data into digitally stored information is of primary importance. This is accomplished by an analog to digital converter (ADC). In order to define what will satisfy your requirements, you need to consider the ADC's data resolution, sampling speed, input types, input levels, number of input channels, and termination.

It is important to know the smallest detectable change in the signal you wish to acquire. This will determine the necessary resolution of your ADC. Analog input resolution is usually expressed as the number of bits of resolution. The ADC represents analog information to the computer as a series of ones and zeros (binary). For a series of eight bits there are 2^8 or 256 discrete values. An ADC with eight bit resolution would divide the full scale potential, the allowable input voltage range (typically 0-10 volts), into 256 divisions. A twelve bit converter then has 2^{12} or 4096 divisions. For example, for an input voltage range of 0-10 volts, a 12 bit converter would be able to see changes as small as 10/4096 divisions or .00244 volts (2.44 mV).

You may also want to express resolution as a percentage change. For an 8 bit converter the percent change of full scale for each division would be 1/256 or 0.39%. The majority of boards on the market today have 12 bit ADC converters. You can still find 8 bit cards, and 16 bit ADCs are also available, but 12 bit cards are the current industry standard.

The next task is to determine how fast to sample your analog inputs to replicate the signal accurately. The Nyquist theorem provides a first estimate for sampling speed. It states that the sampling speed must be at least twice the highest frequency present in the waveform for that waveform to be completely defined. For example, if the signal is a 1 Hz sine wave, samples must be taken at least twice a second in order to replicate the signal. In practice you may actually want to sample at three or four times the Nyquist limit. If you do not follow the Nyquist criteria, you open your data up to the possibility of signal aliasing. Signal aliasing occurs when higher frequency signals "fold over" onto lower frequency signals. This aliasing may be greatly reduced by using a low pass filter before the ADC to attenuate high frequency components.

Most of the PC & Macintosh ADC boards on the market today offer sampling speeds of 30 KHz or more. The sampling rate is determined by software control and can be set for speeds slower price. The Analogic Corporation has designed a family of 16 bit boards ranging from 50 KHz to 1 MHz sampling speeds. The prices of these boards are $1,345 and $3,895, respectively.

The analog inputs can be set up as either single-ended or differential. A single-ended input is one that uses only one wire to carry the signal and shares a common ground. Single-ended inputs are common where noise is not expected to be a problem. Differential inputs use two wires to carry the signal. By taking the difference of the signal in each wire, common mode voltages are easily eliminated. Differential inputs are used primarily where noise or ground loop problems are likely. In many cases the sensor type will dictate which type of input must be used. Most boards offer user selectable 16 single-ended or 8 differential inputs. These inputs are may be expanded to 256 inputs using external multiplexers.

Before selecting a data acquisition board, it is important to know the voltage output level of your transducer. Different boards have different voltage input ranges, with some boards having multiple ranges. Strawberry Tree includes what they call dynamic input ranges on most of their ADC boards.

The most common input range is either unipolar 0-10 volts or bipolar ±10 volts. When working with transducers, like thermocouples and thermistors, or equipment like an electrocardiogram, the input voltage range will need to match the output range of your device closely to achieve maximum dynamic resolution. In the case where your sensor or

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desired number of analog input channels for the project. Most of the standard PC/PS2/Macintosh data acquisition boards have from 4 to 32 input channels. Boards with 16 channels are the most common. For those applications that require more channels than the board offers, many manufacturers provide channel expansion capability in the form of an external channel multiplexer. Channel counts as high as 256 single-ended can be obtained from most manufacturers.

Other considerations include the possible need for acquiring data on multiple channels simultaneously. Several manufacturers make simultaneous sample and hold (SSH) external modules, and at least one manufacturer, Analogic, includes this feature on a number of its PC ADC boards.

Interfacing any data acquisition board to your sensors or instrumentation can be accomplished by a variety of methods. Most manufacturers offer some sort of screw termination panel by which sensor wires are attached to the ADC via a series of screw down connections. For more trouble free interfacing, many manufacturers also offer BNC termination interface panels.

There are also many different varieties of external signal conditioners available for data acquisition. These include input protection from over voltages, optical isolation for protection of the computer and the source, cold junction compensation for thermocouples, and every manner of amplifier and filter. The type and extent of external signal conditioning is determined by the type of sensor to be used. Most of the PC/PS2/Macintosh data acquisition board manufacturers provide external termination panels or modules for signal conditioning.

ANALOG OUTPUTS

The analog output of a data acquisition board is typically used as a control voltage or to generate a signal. There are two main areas to consider for the analog output of a data acquisition board. These are resolution and speed.

The standard digital to analog converter (DAC) resolution is 12 bits. In some research areas, 16 bits of resolution is needed. Both Data Translation and Burr-Brown offer 16 bit DACs on data acquisition boards. Usually one or two DACs are included on a board. For those who need more channels than that, Strawberry Tree sells analog output cards having from 2 to 6 channels.

The speed of the analog output may be important to you, especially in signal generation. For the purpose of control, many analog outputs have latching outputs which stay at the last defined voltage until a new voltage is specified.

While most manufacturers make their analog outputs with voltage outputs, some include the ability to output a 4-20 ma current loop. This is useful in control situations where the surrounding environment is electrically noisy. A current loop transmits a signal based on a proportional current source. For example with a 0-5 volt scale, 4 ma would reference 0 volts and 20 ma would reference 5 volts. These voltages are read through a current to voltage transducer (precision resistor). Because the information is passed as a current and not as a voltage, it is particularly immune to electrical noise.

DIGITAL INPUT/OUTPUT

The digital input/output (DIO) features of most data acquisition boards are quite similar. They are often provided by a single programmable DIO chip. Some manufacturers use discrete logic to perform DIO for increased current source capabilities. DIO lines can range from 2 to 24 or more per board.

The DIO lines may be used to pass information from the data acquisition board to other external devices, trigger events, or control external relays.

COUNTER/TIMERS

Most PC/PS2/Macintosh multifunction data acquisition boards come with some counter or timer functions. These can be used to count pulses, send out pulses, and generate frequency output for timing. Many counter/timers may be used as a pacer clock which is used to initiate and control the rate of data acquisition. On many boards this feature is hard wired.

A very important function of counter/timers is triggering. There are two types of triggering. Post triggering waits for a user-defined event to occur and then signals for sampling to begin. Pre-triggering samples and stores data continuously until a user defined event occurs and to stop data collection. With pre-triggering, the amount of data stored depends on the boards chosen. Some data acquisition boards, like Analogic or Microstar on the PC, have on-board RAM for buffering pre-triggered data quickly and seamlessly.

DATA ACQUISITION SOFTWARE

There are at least three different types of software available for PC or Macintosh data acquisition boards. The three basic types are menu-driven packages, language drivers, and Windows 3.x. In the past few years, many people have become confused about what data acquisition software is available and what it can do. Each of the different types of software packages appeals to specific application needs. It is important, then, to understand how to classify a project's requirements into the appropriate software group.

LANGUAGE DRIVERS

The most basic software for data acquisition products is language drivers for C, C++,Pascal,Fortran, or QBasic. This software is only used for creating your own data acquisition program. All of the PC/PS2/Macintosh data acquisition vendors offer an array of drivers. These language drivers are only useful if you can program in these languages. They offer limited use for the novice. It is also important to make sure the language driver is available in the particular language you use. For example, suppose you only know how to program in Pascal. It is very important, then, to make sure the language driver you order comes with the routines in Pascal.

The drivers perform the low level software interface to the data acquisition board. This allows for quicker software development. Some manufacturers (eg, National Instruments and American Advantech) supply language drivers free with their data acquisition boards. Other vendors charge for software drivers.

It is very common for scientists to pass along developed software. This is usually called shareware. These programs usually work with a specific data acquisiton board and have limited documentation. If you have seen a software package you liked, this is the easiest way to decide on the hardware platform and data acquisition products.

It is important to understand that software development with language drivers may take some time to get operating. Before choosing to develop any program, contemplate the required hours of programming, debugging, and documenting needed to develop a software package. It may be easier to buy an already developed product in the long run.

Menu Driven Software

There are many "menu-driven" software packages available in the MS-DOS, Macintosh, and Windows market. But first, lets define what is meant by a "menu-driven" software package. These packages are characterized by easy-to-use menus that guide a user through the setup, operation, and acquisition of data. Typically, these packages require little or no programming experience. A menu driven software package is usually the easiest way to get up and running in a matter of minutes.

There are many differences in all the menu-driven software packages. Some of these programs will only run with specific data acquisition boards. It is important to ask which boards the software supports. These packages also vary differently in performance, functionality, and price. The cost of these software packages can range from nothing to several thousand dollars.

So where do you begin? First start with the data acquisition hardware you have chosen for the application. Then ask the software vendor if it supports the specific board you have chosen. It is also possible to see some software you like before you have selected an ADC board. In that case, find out from the vendor which cards are supported, and choose the appropriate card from the hardware specifications. Also, ask your friends or colleagues what they would suggest. Often this is the best source for getting information because they may have good or bad past experience with a product. It is also important to check with the software vendor on recent updates or releases. These products are updated frequently.

The most popular menu driven DOS package is LabTech Notebook from Laboratory Technologies. This product has been very popular for many years and is a very stable product. The suggested price is $995.

The most popular Macintosh package has been Labview by National Instruments. This package is extremely easy to use and offers a great deal of function and flexibility. The price of $1,995 is a little high for a limited budget.

Microsoft Windows 3.x

The introduction of Windows 3.x has really set in motion a tremendous movement for use in data acquisition applications. There are currently no programming standards for using Windows in this market and many vendors are promoting their specific software platform. It is true that Windows 3.1 and NT offer many exciting features for the data acquisition market and it will become our standard of the future. Already there are several data acquisition software packages available for use under the Windows 3.x environment.

The best question to ask is, "Do you really need Windows for your application?" There are many issues involved in acquiring data with Windows that go beyond the scope of this article. This market is still in its infancy, and it may take a few years for the market and products to develop. We would recommend speaking directly to the software vendors, and outline your specific project requirements to see if Windows is a viable option for you. Also, reviewing product literature may answer many of your hardware or software questions.

National Instruments is currently shipping, free of charge, both MS-DOS and Windows DLL drivers with their data acquisition products for the PC. Also, HEM Data is shipping SnapMaster for Windows which is a data acquisition and display software package. Scientific Software Tools offers Windows drivers in Visual Basic and C for developing a Windows application.

We are very excited about the impact Windows will have on the data acquisition market. Right now many of the technical details must be worked out, but soon the market will truly see some user-friendly software, easy to use, and inexpensive.

ON A BUDGET?

Many of our educational institutions are really feeling the budget crunch these days. Many people ask what is available in the market for those with limited funds? Start with the software. Find a colleague who wrote a program that will suffice, and find out what hardware it uses. It is also possible to find inexpensive ADC boards in some of the computer journals or swap meets. Just look in the back of Byte magazine, in the back section with the really small advertising squares. Many of these companies offer inexpensive products.

We can also recommend the American Advantech PCL-711S. This hardware and software package is a great value. For $295 you get an ADC card, a termination strip, and software. This is a perfect choice for a teaching laboratory or small application. American Advantech offers other products in various price ranges and offers a free product catalog.

CURRENT MARKET TRENDS

We already mentioned the biggest trend is Windows 3.x for the software market. The hardware market is moving at a much slower pace, but it is still very exciting.

Currently, many vendors are offering 16 bit and 24 bit analog input cards for a variety of applications. The chromatography market has really changed with the introduction of higher resolution boards and the Windows environment. The cost of these boards are competitive with some of the 12 bit boards too. Analogic offers the 100 KHz 16 channel 16 bit LSDAS-16 for $995. National Instruments has also just released the AT-MIO-16X for the PC and Macintosh/NUBUS. Many vendors are offering faster analog input sampling speeds too. It is possible to find a 1-2 MHz analog sampling speed from a variety of vendors. These products from Analogic and others can cost from $3,000-$5,000. There are many technical issues, such as data storage devices, data buffering, and computer BUS limitations, surrounding these fast sample speeds that require a good understanding of the specific application.

We hope that this article offers some practical, unbiased, information about the data acquisition market and products. This market has expanded greatly over the years, and it can be confusing, but look for some very exciting products in the future.

REPRESENTATIVE DATA ACQUISITION HARDWARE VENDORS

The following list of hardware vendors should provide a good starting point for investigating data acquisition systems.

Acces
9400 Activity Road
San Diego, CA 92126
(619) 693-9005

ADAC Corp.
70 Tower Office
Woburn, MA 01801
(617) 935-6668

American Advantech
1310 Tully Rd. #115
San Jose, CA 95122
(408) 293-6786

Analogic Corporation
360 Audubon Road
Wakefield, MA 01880
(800) 446-8936

Burr-Brown
1141 W Grant Road
Mailstop 131
Tucson, AZ 85705
(602) 623-9801

Computer Boards, Inc.
44 Wood Avenue
Mansfield, MA 02048
(508) 261-1123

Data Translation
100 Locke Drive
Marlborough, MA 01752
(508) 481-3700

Dataq Instruments, Inc.
150 Springside Dr.
Suite B220
Akron, OH 44333
(216) 688-1444

Datel, Inc.
11 Cabot Blvd
Mansfield, MA 02048
(800) 223-2765

Industrial Computer Design
31264 La Baya Drive
Westlake Village, CA 91362
(818) 889-3179

Metrabyte Corp.
440 Myles Standish Blvd
Taughton, MA 02780
(508) 880-3000

Microstar Laboratories
2265 116 Avenue N.E.
Bellevue, WA 98004
(206) 453-2345

National Instruments
6504 Bridge Point Parkway
Austin, TX 78730
(800) 433-3488

Quatech
662 Wolf Ledges Pkwy
Akron, OH 44311
(216) 434-3154

RC Electronics
6464 Hollister
Santa Barbara, CA 93117
(805) 685-7770

Scientific Solutions
6225 Cochran Rd.
Solon, OH 44139
(216) 349-4030

Strawberry Tree
160 South Wolfe Rd.
Sunnyvale, CA 94086
(408) 736-8800

Validyne Engineering
8626 Wilbur Avenue
Northridge, CA 91324
(818) 886-2057

REPRESENTATIVE SOFTWARE VENDORS

The following list of software vendors should provide a good starting point for investigating a variety of programs meant to be used with analog-to-digital conversion systems.

Alligator Technologies
17150 Newhope St., Ste. 114
Fountain Valley, CA 92728-9706
(714) 850-9984

Software: Fourier Prospective III

Bioscience
3630 Morley Trail N.W #217K
Box 61254
Calgary, Alberta,Canada T2L2K6
(403) 547-1332
Software: DataSponge 3.0

HEM Data Corp.
17336 Twelve Mile Road
Southfield, MI 48076
(313) 559-5607

Software: SnapMaster for Windows 3.x & MS-DOS

Keithley Asyst Corp.
440 Myles Standish Blvd.
Taughton, MA 02780
(800) 348-0033
Software: Asyst

Laboratory Technologies
400 Research Drive
Wilmington, MA 01887
(508) 657-5400

Software: Notebook and Control

National Instruments
6504 Bridge Point Parkway
Austin, TX 78730
(800) 433-3488
Software: Labview (MAC, PC, SUN)

Scientific Software Tools
30 East Swedesford Rd.
Malvern, PA 19355
(215) 889-1354
Software: DriverLinx for Windows 3.x

NRCLSE 1992 COLLEAGUE DIRECTORY

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows was drawn from respondents to questionnaires printed in earlier issues of CLSE. It is intended to help readers identify colleagues with common interest areas.

The listingis arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although we have attempted to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights.

If you are aware of other colleagues that should be listed, please encourage them to send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

NRCLSE
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or let us know via BITNET. NRCLSE's BITNET address is MODELL@ UWALOCKE.

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Harold I. Modell, *Editor*

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SD = Strongly Disagree
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N = Neutral
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7. During the past year, I have told at least one colleague about information that appeared in CLSE.	SD	D	N	A	SA
8. The quarterly publication schedule suits my needs better than the monthly format did.	SD	D	N	A	SA
9. CLSE has outlived its usefulness and should be discontinued.	SD	D	N	A	SA

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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CONTENTS

DEVELOPING SIMULATIONS TO HELP STUDENTS LEARN RENAL PHYSIOLOGY 65
Harold I. Modell

KEEPING ABREAST OF THE LITERATURE 78

INDEX FOR VOLUME 9 79

DEVELOPING SIMULATIONS TO HELP STUDENTS LEARN RENAL PHYSIOLOGY

Harold I. Modell
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Traditionally, opportunities for active learning in physiology courses have taken the form of student laboratories. Through this format, students were able to examine various aspects of living systems using live animal preparations or, more recently, computer simulations. In either case, the intent was to have students pose questions and seek answers to those questions through experimentation. In response to the rising costs of live animal laboratories, many curricula have turned to computer simulations as a vehicle for students to engage in hypothesis testing activities.

In the mid-1970s, we completed a series of simulations dealing with various aspects of respiratory physiology.[6] The intent was to provide students with a means of building understanding of the respiratory system by working initially with relatively simple models and progressing to more complex ones. The set of programs, therefore, covered a broad range of topics relevant to respiratory physiology. Since that time, a critical mass of simulations has become available so that faculty may provide computer-based laboratories covering not only respiration but also a wide variety of topics in cardiovascular physiology, muscle physiology, and neurophysiology.[4] Simulations developed for use in renal physiology curricula have been limited and cover only one or two aspects of renal function.[4] Following the same

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underlying philosophy as our respiratory simulations,[5] we set out to develop a series of simulations in renal physiology. In doing so, it was necessary to first address a number of issues related to educational philosophy, computer hardware, and computer software as well as issues related to renal physiology before the package could be completed.

EDUCATIONAL ISSUES

The primary goal of the project was to produce resource materials that could be used to promote an active learning environment for students of renal physiology. Our first task was to develop a clear definition of what we mean by an "active learning environment" and to establish how this definition would impact on the various potential components (tutorials, "laboratories", documentation) of the overall package.

An active learning environment is one in which students are engaged in the process of building and *applying* their own mental models of the topic under consideration. The traditional lecture environment in which an instructor disseminates information to a group of students is not an active learning environment. Although some might argue that the effective lecturer leads the student through the material in a way that helps her build a mental model, the format does not provide a mechanism for the student to test or apply that model. The traditional laboratory exercise, presumably designed to actively engage students, may also not meet our definition. If the laboratory protocol followed by the student is entirely prescriptive, that is, if the narrative only directs the student to perform a task, record data, do another task, record data, and, finally, after a series of observations asks questions about the data, the student performs the tasks because he or she has been directed to do so. Students have been "active" (i.e., doing something) during the laboratory, but the exercise has not encouraged "active learning" because they have not been encouraged to test their own mental models of the system. To promote active learning, the protocol should focus the student on the rationale behind each step, ask the student to predict the outcome of the step, and consider the implications of the data as it is obtained.[3]

The key to providing an active learning environment lies with how the "teacher," or in our case, the developer, views his or her role in the process. In the passive learning environment of the lecture hall, the lecturer (teacher) disseminates information. The good lecturer does this in a manner that helps the student organize the information, and, in this respect, the role of the lecturer is to impart knowledge. However, the presence of students in the lecture is not essential to this process; a videotape may provide the student with the same experience that is available in the classroom. The presence of students in an active learning environment, however, is essential. In this environment, the role of the teacher is to help the learner to learn. Thus, the focus moves from the lecturer (teacher) imparting knowledge to the student (learner) integrating the knowledge into an existing personal framework, and the teacher must repeatedly interact with the student to determine how he or she can help the student with this integration process. This interaction must not only include the types of questions often posed by a lecturer in a rhetorical manner (e.g., Where does this lead?), but also other response-seeking questions designed to give the teacher some insight into how the student interprets the information presented (e.g., What do these data mean to you?). The teacher must be prepared to alter his or her instructional path based on the responses received.

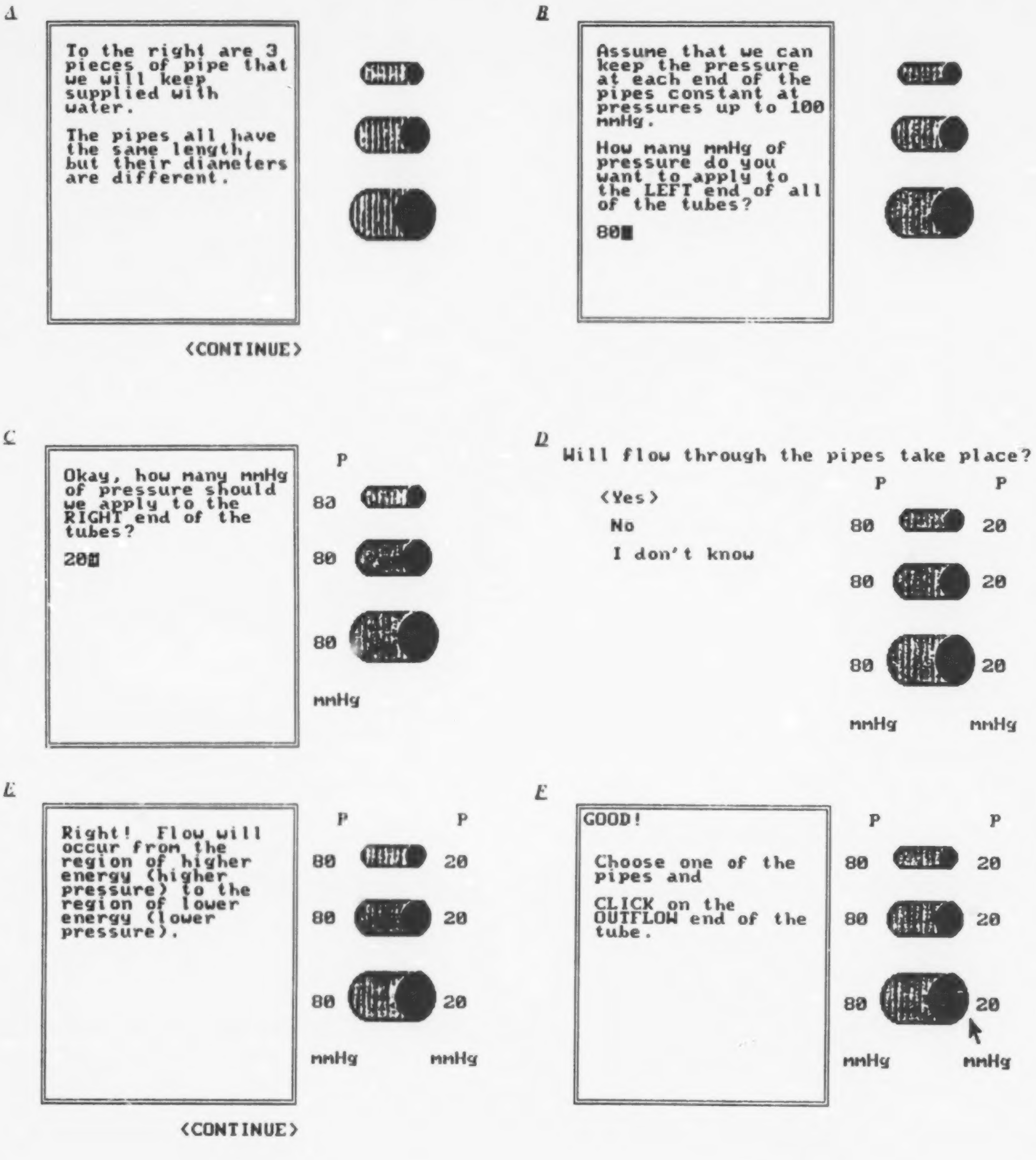
What implications does this view have for designing the components of the renal package? To be consistent with this view, all components must foster a learning environment in which students are encouraged to reason from specific facts to general concepts and one in which students can work in an exploratory mode to test their understanding (mental model) of the system in a variety of situations. To ensure this consistency, a set of guidelines were established for programs in which simulations were to be used in a tutorial mode, for programs in which the simulations were intended to serve strictly as a "laboratory preparation," and for the "laboratory" manual that could be used to direct students working with the "laboratory preparation" programs.

Tutorial programs

The format of traditional computer-based tutorials is not consistent with an active learning environment as we have defined it. In traditional computer-based tutorials, the student is first presented with information about a topic. She is then asked questions about the information just presented and receives feedback based on her response. While the student is engaged in an interactive session to varying degrees, the format seldom includes the opportunity for the student to test her mental model of the system in an exploratory way.

To fit with our definition of an active learning environment, the program must provide an opportunity for the student to make predictions based on her own mental model of the system under study and run an experiment to see if the prediction is correct. The program must also assess whether the student's interpretation of the experiment is consistent with the generally accepted model of the system. These requirements change the format from a presentation-question mode to a dialog mode in which the student shares in the design of experiments intended to help her discover whether her prediction is correct. The process is illustrated in the series of screens shown in Figure 1. The series, taken from the first program in the package, is the beginning of a dialog dealing with flow through tubes.

The screen in Figure 1A begins to set up the experiment. In the next screens (Figure 1B and 1C), the student is asked how much pressure should be applied to


A
<CONTINUE>
B
C
P
80
80
80
mmHg
D
<Yes>
No
I don't know
P
P
80
20
80
20
80
20
mmHg
mmHg
E
P
P
80
20
80
20
80
20
mmHg
mmHg
<CONTINUE>
E
P
P
80
20
80
20
80
20
mmHg
mmHg

A

```
To the right are 3
pieces of pipe that
we will keep
supplied with
water.

The pipes all have
the same length,
but their diameters
are different.
```

B

```
Assume that we can
keep the pressure
at each end of the
pipes constant at
pressures up to 100
mmHg.

How many mmHg of
pressure do you
want to apply to
the LEFT end of all
of the tubes?

80█
```

C

```
Okay, how many mmHg
of pressure should
we apply to the
RIGHT end of the
tubes?

20█
```

D

```
Will flow through the pipes take place?
```

E

```
Right!  Flow will
occur from the
region of higher
energy (higher
pressure) to the
region of lower
energy (lower
pressure).
```

E

```
GOOD!

Choose one of the
pipes and

CLICK on the
OUTFLOW end of the
tube.
```

FIGURE 1. Partial program-student dialog from the review of hydrostatic forces portion of the Water Movement in the Kidney tutorial (see text).

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the left and right sides of all of the tubes. The intent is to make the student an active participant in the experimental design, and, in some measure, to fit the exercise to the student's train of thought. Thus, the student can establish the pressure difference so that water flows from right to left or from left to right. In this way, the "teacher" (program) designs the example to fit within the mental framework of the student, and the student is not required to reorient his frame of reference. After establishing the pressures on each side of the tube, the student is asked if flow will take place through the tube (Figure 1D). Note that we consider "I don't know" a legitimate answer. If we are to help the learner to learn, we must provide for instances in which the student feels that he does not have enough information or understanding to make a reasonable prediction. In this case, the dialog would be extended so that the student could recognize that when a pressure difference exists, flow will occur. The program then further tests the student's understanding of the model (Figures 1E and 1F). In subsequent screens, the student is asked to predict if flow through the three pipes will be the same. To learn if the prediction is correct, an experiment is run in which outflow from the pipes is collected for a time period specified by the student. The dialog continues with a discussion of resistance and its relationship to pipe diameter (radius).

Simulations as laboratory preparations

At first thought, the educational issues related to promoting an active learning environment do not appear to impact the simulations intended to serve as a laboratory preparation. After all, any simulation that provides the student with the possibility of performing a broad spectrum of experiments should provide a vehicle for testing his or her mental model. However, if the programs are to help the learner to learn, there are several issues that need to be addressed. As is the case when simulating any complex system, simplifying assumptions are necessary. If the student is to test his mental model against a simulations of the "real world," he must have some idea of how simple or complex the "real world" model is. Thus, it is essential that each program include a list of the key simplifying assumptions that underlie the simulation.

The second issue that must be addressed is the range of complexity of the simulations. If we are to help the learner to learn, it is counterproductive to present the most complex model possible without first establishing a suitable foundation. This is done by providing several simulations along a spectrum of complexity. For this software package, we adopted the philosophy of our earlier programs that the series should begin with relatively simple models based on a limited number of principles followed by larger complex models.[5] We chose, then, to have 3 models focusing on glomerular capillary dynamics, the proximal tubule, and the distal nephron, respectively, before dealing with a more complete model that includes neural and hormonal regulation of renal function.

The design of output screens is another area that is impacted by the underlying educational philosophy. Several options exist for presenting the results of the experiment to the student. Data generated by the model could be represented in the form of data plots. However, the simulations in this package are all steady-state models. Thus, to provide this format, several iterations of the model would be necessary to obtain the data. Another alternative is to present a pictorial that helps students build a conceptual model of the system under investigation or indicates schematically where the various parameters are measured in the system. Adopting the latter alternative is consistent with our goal of helping the learner to learn in that providing a schematic diagram may help the student visualize how the various relevant factors interact. This is illustrated by an output screen from the glomerular dynamics program presented in Figure 2. This screen depicts the relationship between the afferent arteriole, the glomerular capillary, the efferent arteriole, and

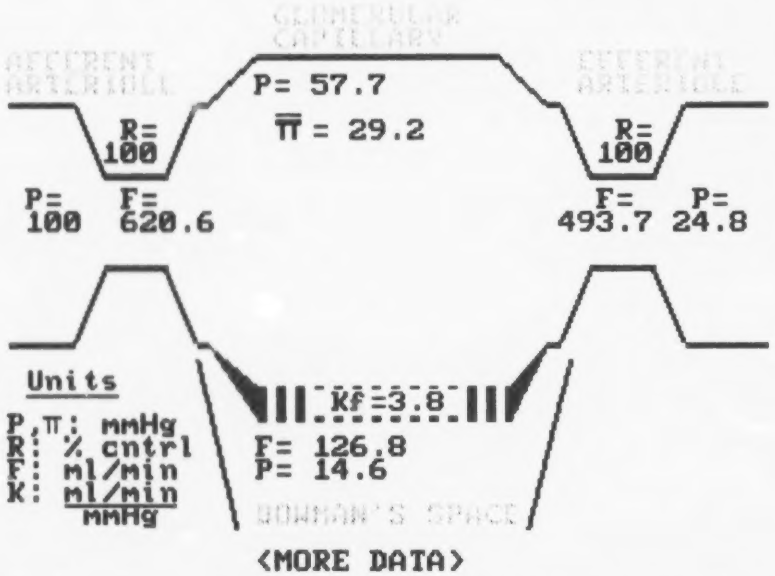

FIGURE 2. Primary output screen presenting data in the Glomerular Capillary Dynamics program.

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Bowman's space. Placement of the variable values indicates that flow into and out of the glomerular capillary occurs from regions of higher pressure to regions of lower pressure through a resistance. The filtration coefficient (Kf) is associated with the glomerular capillary membrane and reflects the resistance to flow (filtration) between the glomerular capillary and Bowman's space. Furthermore, the placement of variable values in the glomerular capillary and Bowman's space suggests to the student that the concept of flow within the vasculature and flow across the glomerular capillary are analogous. Filtration (flow) across the capillary occurs from a region of higher net pressure to a region of lower net pressure through a resistance (Kf).

Finally, the underlying educational philosophy impacts how the student is told that an error has been made. Errors can arise either when values entered as input variables are physiologically unreasonable or when the combination of inherently reasonable input values results in a response that is physiologically unsound. In both cases, it is essential that the error message presented indicate the physiological consequences of the error so that encountering an error also results in a learning experience for the student. For example, one of the input variables in the glomerular capillary dynamics model is arterial pressure. If the student enters a value that is not high enough to support filtration, the student is told that the nephron has stopped filtering. In the distal nephron model, a combination of individually realistic input values can result in a situation in the simulation in which sodium reabsorption is complete before the distal nephron is reached. In this situation, the simulation fails. If this condition arises, the student is told that all of the filtered sodium has been reabsorbed before the collecting duct and that reabsorptive mechanisms in the collecting duct will not function properly.

Laboratory manual

The same educational issues addressed with regard to the computer simulations needed to be addressed with regard to any written materials developed for students who may use the simulations. Because potential users of the simulations represent populations ranging from undergraduate to postgraduate students, the documentation must be serve a variety of needs. Furthermore, if the software is to be useful in a variety of educational formats (e.g., independent study, student laboratories, and group study involving one computer and many students), it is best if the documentation is provided as a separate workbook rather than being incorporated into the software.

To serve the spectrum of student populations, the workbook should include a short "textbook" type review for each simulation describing relevant aspects of the system being simulated. For the undergraduate student studying renal physiology for the first time, this would be important as a restatement of material discussed in class, reinforcing relationships and defining terms. For the more advanced student it would be important as a review to help orient him to the specific simulation being investigated. Following this, the documentation should give the student some indication of what types of studies in the context of the background review can be run with the simulation.

Because the software provides summary screens containing the simplifying assumptions, a description of the input parameters is required, and description of the variables can be "measured" in the simulation, it was decided that this information need not be repeated in the written documentation.

Finally, the documentation should provide some direction for the student using the simulation for the first time. Educational issues impact on this direction in two ways; the extent of the direction and the format in which the direction is presented. If minimal direction is provided, a student must rely on past experience (which may not be extensive) and on his or her understanding of the system to define the scope of the study to be run and to determine specific values to input. If, on the other hand, direction is provided to the point where the entire scope of the study and all possible ramifications are discussed, the package runs the risk of become a high-technology textbook that does not offer the student an active learning environment. The compromise that worked well for our previous respiratory models was adopted for these simulations as well. A limited number of trial values and suggestions for various ways to analyze the data would be provided in a suggested procedure for each model.

The format of the direction is also critical. It must challenge the student to apply his or her own mental model of the system being investigated. Thus, instead of suggesting that the student increase or decrease a variable value and see how this affects the system, the student should be prompted to predict how the system will be affected if a specific variable changes. This is illustrated in Figure 3 which presents an excerpt from the suggested procedure accompanying the glomerular capillary dynamics model. Through this format, the experiment becomes an exercise in hypothesis posing and testing rather than an exercise in associating directional changes with observed outcomes.

COMPUTER ISSUES

Several governing criteria related to computer issues had to be established before development of the software was begun. The first decision related to the platform chosen for the programs. One tendency in developing new software is to make use of "state of the art" equipment and utilize all of the "bells and whistles" available at the time when the software is generated. While this approach can lead to some wonderfully sophisticated programs, it is doubtful that the intended population will be able to utilize the software because of a lack of appropriate equipment. Most institutions do not have state of the art equip-

2. Determine what happens when only one of the control values has changed.

    A. How should changes in afferent arteriolar resistance affect renal plasma flow and glomerular filtration rate?

    On the axis below, plot renal plasma flow (RPF) and glomerular filtration rate (GFR) as functions of afferent arteriolar resistance.

    Do the data support you prediction?

    How would you account for the changes in RPF and GFR that resulted from changing afferent arteriolar resistance?

    What happened to the filtration fraction as afferent arteriolar resistance changed? Is this what you would have predicted?

FIGURE 3. Excerpt from the suggested procedure portion of the "laboratory" manual dealing with the Glomerular Capillary Dynamics program.

ment in their student computer facilities, and many students have minimal systems at home. The appropriate platform is the one most readily found in the environment for which the software is intended. Because many schools have chosen to adopt an MS-DOS platform while others have adopted Macintosh equipment, we decided that, ultimately, the software must be available for both MS-DOS and Macintosh environments. Furthermore, the platform must be an acceptable "minimum configuration" of each type of computer. For the MS-DOS environment, we defined our minimum configuration as a machine with a 286 processor, 640 KB of memory, VGA graphics, and a mouse. The Macintosh SE was adopted as the minimum configuration for the Macintosh environment.

The decision to have versions of the software available for both MS-DOS and Macintosh platforms led to a number of other decisions related to the user interface, the language chosen, and, to some extent, screen design. The user interface should utilize the mouse to select menu items and, where appropriate, as a vehicle for interaction with the student.[1] The language chosen for development should be one that would require a minimum of modification to the source code in moving from one platform to the other. QuickBASIC for the Macintosh and its superset, the Microsoft BASIC Professional Development System (PDS) fit this requirement.[2] PDS BASIC includes a toolkit that supports mouse use and includes a provision for utilizing windows to emulate a number of Macintosh ToolBox functions (e.g., the TextBox function, menu "buttons"). By choosing these development systems, subroutines could be written for the MS-DOS platform that utilized the source code syntax required for Macintosh QuickBASIC access to the Macintosh ToolBox. In this way, the overall look of the programs could be designed so that the hardware platform would be nearly transparent to the student. That is, after initiating the main menu for the software package, the student would be exposed to the same educational experience regardless of whether he is working on an MS-DOS machine or on a Macintosh.

Screen resolution was another area given serious consideration. Because the programs are intended for use in the classroom (e.g., with a liquid crystal display panel and overhead projector) as well as for use with individuals or small groups of students that could view a single monitor, it was necessary to choose a resolution convention that would result in an easily readable image when projected. Thus, all output screens would be limited to "40 column" resolution.

RENAL PHYSIOLOGY ISSUES

Having established a governing philosophy with respect to the form and format of the programs, it was necessary next to decide exactly what aspects of renal physiology the programs would cover. Initially, it was decided that the package would include programs dealing with forces responsible for water movement, glomerular capillary dynamics, reabsorption of water and solutes in the proximal tubule, transport mechanisms, the renal concentrating mechanism, exchange in the distal nephron, neural and hormonal regulation of renal function, and acid-base balance.

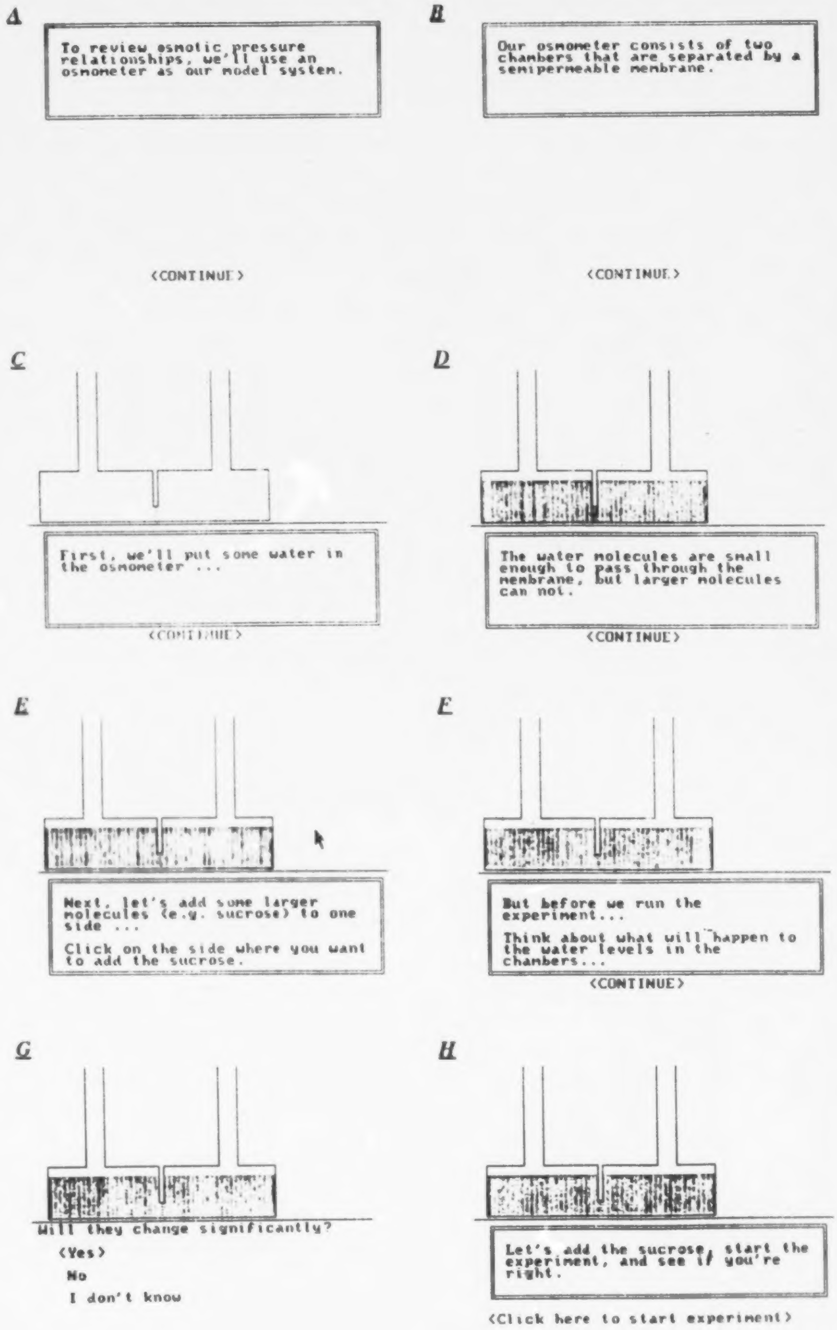
The underlying model for the "experimental" simulations would be the research model developed by Roman and Sias[8] that predicts a number of variables related to renal function (including flows, pressures, and solute concentrations within the nephron) as a function of arterial pressure and the levels of neural and hormonal inputs to the kidney. Portions of this model would be used as the basis for the glomerular capillary dynamics program, the proximal tubule program, the distal nephron program, and the total nephron program focusing on neural and hormonal regulation of renal function.

The acid-base program would deal with total body acid-base balance using the base excess approach rather than focusing specifically on the renal mechanisms of hydrogen ion exchange.

Simulations would be used in a tutorial format to help students understand forces responsible for water movement in the kidney and molecular transport mechanisms at work in the nephron

Deciding on an appropriate format for the remaining topic, the renal concentrating mechanism, presented somewhat of a challenge. Several factors contributed to this. The generally accepted model of the concentrating mechanism is Stephenson's central core model of the renal medulla.[9] However, to solve this model requires considerably more computing power than is available on the personal computers for which this package was to be targeted. Hence, we first decided to approach the topic through a tutorial format. The next logical step, then, was to determine what content should be covered by the tutorial. Although the descriptions of the renal concentrating mechanism in most textbooks are consistent with the central core model of Stephenson, this model does not fully account for the effects of regional blood flow heterogeneities that have been observed in some mammalian kidneys,[7] nor does it take into account the potential influence of blood flow changes resulting from regulators of medullary blood flow (e.g., vasopressin). The dilemma that arises, then, is whether the tutorial should try help the student understand only the countercurrent multiplier system or deal with broader issues relevant to controlling the renal medullary concentration gradient. We concluded that, rather than delay the package, it would be best to study the issues further before including a program devoted to this topic.

We also reconsidered including a tutorial on molecular transport mechanisms in this series of programs. Although it is certainly important for students to understand the various types of transport mechanisms at work in the kidney, the essential features of these mechanisms are common to transport mechanisms in other areas of the body. Because we feel it important for students to recognize that similar processes take place in a variety of physiological systems, we decided that a tutorial dealing specifically with molecular transport mechanisms should be presented in a series of programs emphasizing "common themes" in physiology. The same argument could be made for the tutorial on forces governing



To review osmotic pressure relationships, we'll use an osmometer as our model system.

Our osmometer consists of two chambers that are separated by a semipermeable membrane.

First, we'll put some water in the osmometer ...

The water molecules are small enough to pass through the membrane, but larger molecules can not.

Next, let's add some larger molecules (e.g. sucrose) to one side ...

Click on the side where you want to add the sucrose.

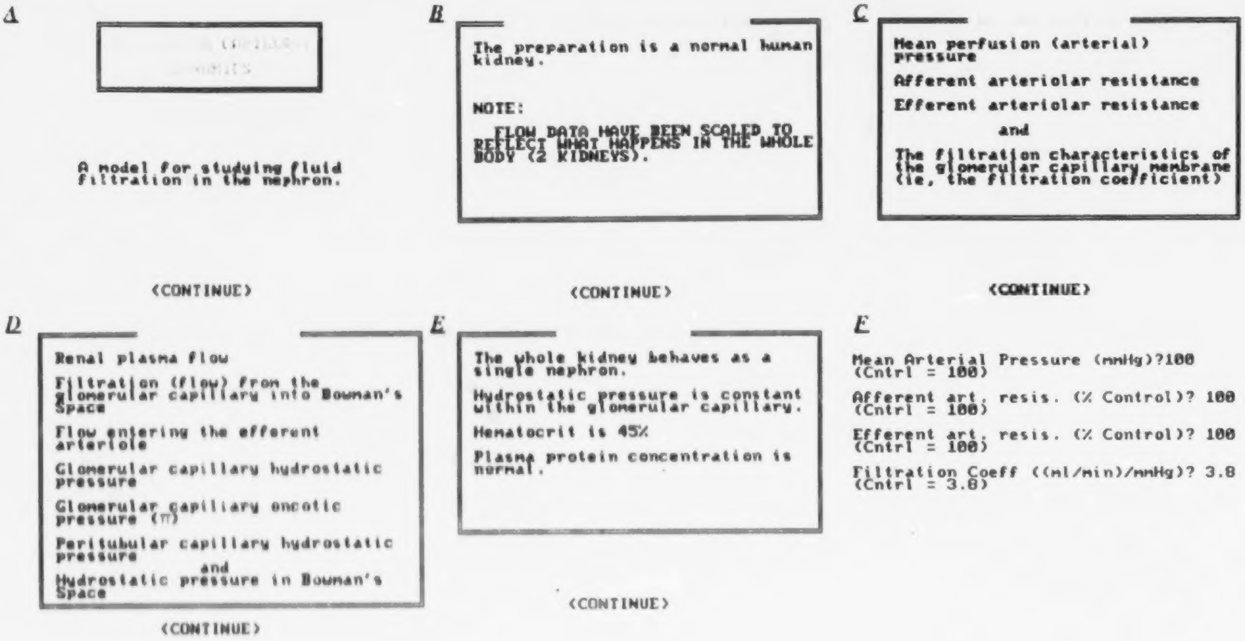
But before we run the experiment...

Think about what will happen to the water levels in the chambers...

Will they change significantly?

Let's add the sucrose, start the experiment, and see if you're right.

FIGURE 4. Partial program-student dialog from the review of osmotic forces portion of the Water Movement in the Kidney tutorial.



```
A model for studying fluid
filtration in the nephron.

<CONTINUE>
```

```
The preparation is a normal human
kidney.

NOTE:
   FLOW DATA HAVE BEEN SCALED TO
REFLECT WHAT HAPPENS IN THE WHOLE
BODY (2 KIDNEYS).

<CONTINUE>
```

```
Mean perfusion (arterial)
pressure

Afferent arteriolar resistance

Efferent arteriolar resistance

          and

The filtration characteristics of
the glomerular capillary membrane
(ie, the filtration coefficient)

<CONTINUE>
```

```
Renal plasma flow

Filtration (flow) from the
glomerular capillary into Bowman's
Space

Flow entering the efferent
arteriole

Glomerular capillary hydrostatic
pressure

Glomerular capillary oncotic
pressure (π)

Peritubular capillary hydrostatic
pressure
                and
Hydrostatic pressure in Bowman's
Space

<CONTINUE>
```

```
The whole kidney behaves as a
single nephron.

Hydrostatic pressure is constant
within the glomerular capillary.

Hematocrit is 45%

Plasma protein concentration is
normal.

<CONTINUE>
```

```
Mean Arterial Pressure (mmHg)?100
(Cntrl = 100)

Afferent art. resis. (% Control)? 100
(Cntrl = 100)

Efferent art. resis. (% Control)? 100
(Cntrl = 100)

Filtration Coeff ((ml/min)/mmHg)? 3.8
(Cntrl = 3.8)
```

FIGURE 5. Introductory screens from the Glomerular Capillary Dynamics program.

water movement. However, understanding the interaction of hydrostatic and osmotic forces is critical to understanding filtration and reabsorption, and, hence, should be included in both a series of programs devoted to renal function and a series focused on common themes in physiology.

PROGRAM DESCRIPTION

As a result of the decisions regarding the renal concentrating mechanism and molecular transport mechanisms, the current package includes six programs; one tutorial program dealing with water movement in the kidney, four "experimental" simulations dealing with various aspects of the nephron, and one "experimental" simulation dealing with total body acid-base balance. The programs are designed to be used by a computer novice. The student need only recognize that, when entering information from the keyboard, it is necessary to press the "Return" (Enter) key to signal the end of the input. The introduction to the programs explains user interface. It then gives the student an opportunity to practice choosing menu options with the mouse before presenting the main menu.

Water Movement Tutorial

The first program in the series is the tutorial dealing with forces responsible for water movement in the kidney. The first section of the program focuses on pressure-flow relationships in tubes. Through a series of experiments, the student examines the influence of tube radius (diameter) on resistance, flow through resistances in series, and flow through resistances in parallel. It is important for students to recognize that their models must be tested against the real world. Thus, this section of the program concludes with a discussion of distensible tubes and transmural water movement in vessels and renal tubules. The remaining portions of the program use the same experimental approach to help the student examine osmotic pressure and the interaction between osmotic and hydrostatic forces in determining water movement through semipermeable membranes.

The format of the computer-student interaction is illustrated in Figures 1 and 4. Figure 1 shows the initial screens the pressure-flow section of the program. An example of dialog from the osmotic pressure section of the program is shown in Figure 4. The intent is to carry out a dialog with the student in a way that helps him begin to pose questions and seek answers rather than merely assimilate information.

Simulations of the Nephron

The "laboratory experiment" simulations all follow the general format illustrated in Figures 5-7. Each program begins by describing the experimental preparation, listing the parameters over which the user has control, and listing the variables that can be measured (i.e., the output data). This if followed by a listing of the key assumptions in the model. The user then enters values that will define the

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"experiment." On this screen (Figure 5F), typical control values for the input parameters are presented for the student's reference. On subsequent input screens, the control value is replaced by the current value of the parameter. After the simulation is run using the input values, one or more output screens containing both the input and output data are presented (Figure 6). The intent of the output screens is to present a pictorial to serve as an aid for the student's conceptualization of the physiology of that component of the system. Following presentation of the data, the student is given the option of saving the data, comparing the data with previously saved experiments, reviewing previously saved experiments, or changing parameter values (Figure 7A). Data from six experiments can be saved at any given time. If the student chooses to compare data, the output values from the two experiments being compared are presented on the pictorial (Figure 7B).

Table 1 summarizes the nephron simulations in terms of their input parameters and output variables. The output (data) screens from the proximal tubule, distal nephron, and total nephron programs are shown in Figures 8-10. After viewing the first output screen in the total nephron model, the student is given the option to view screens representing events in the glomerular capillary, proximal tubule, cortical distal nephron or medullary collecting duct (Figure 10). Thus, the renal series allows the student to study factors affecting each component of the system in isolation before considering more complex interactions between components of the system.

Acid-Base Simulation

The acid-base balance program takes a base excess approach to enable students to view acid-base relationships from a total body standpoint. Specific renal mechanisms of hydrogen ion balance are not included in the model. The same general format illustrated for the nephron simulations in Figures 5-7 is followed in this program. The student provides values for hemoglobin concentration, arterial carbon dioxide tension, and the amount of fixed acid added or removed from the system. In response, the program calculates blood and plasma bicarbonate concentrations, blood protein anion concentration, plasma pH, and the total concentration of anions available for buffering in the blood.

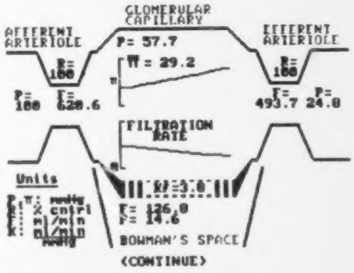
GLOMERULAR CAPILLARY
AFFERENT ARTERIOLE
EFFERENT ARTERIOLE
P= 57.7
π = 29.2
π
R= 100
R= 100
P= 100
F= 620.6
F= 493.7
P= 24.8
FILTRATION RATE
0
Units
P,π: mmHg
R: % cntrl
F: ml/min
K: ml/min mmHg
Kf=3.8
F= 126.8
P= 14.6
BOWMAN'S SPACE
<CONTINUE>

FIGURE 6. Second data screen from Glomerular Capillary Dynamics program (see Figure 2 for previous screen).

Figure 11 presents the primary output screen from this program. The intent of this screen is to help students understand the interrelationship between the bicarbonate and protein buffer systems and the conditions under which the base excess (the concentration of total anion available for buffering compared to its normal value) changes. As in the other simulations, the students can save and compare data from up to six experiments.

EVALUATION

The criteria defining appropriate evaluation of software designed to be used by multiple student populations and in multiple educational settings are difficult to

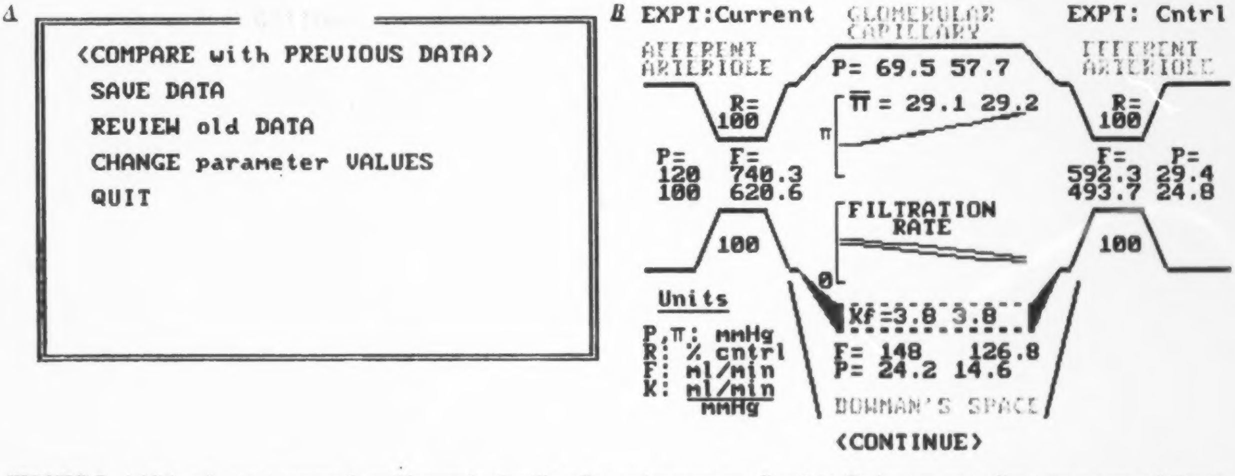
A
<COMPARE with PREVIOUS DATA>
SAVE DATA
REVIEW old DATA
CHANGE parameter VALUES
QUIT
B
EXPT:Current
GLOMERULAR CAPILLARY
EXPT: Cntrl
AFFERENT ARTERIOLE
EFFERENT ARTERIOLE
P= 69.5 57.7
π = 29.1 29.2
π
R= 100
R= 100
P= 120 100
F= 740.3 620.6
F= 592.3 493.7
P= 29.4 24.8
FILTRATION RATE
100
100
0
Units
P,π: mmHg
R: % cntrl
F: ml/min
K: ml/min mmHg
Kf=3.8 3.8
F= 148 126.8
P= 24.2 14.6
BOWMAN'S SPACE
<CONTINUE>

FIGURE 7. Additional output screens from Glomerular Capillary Dynamics program. *Panel A:* Options menu to direct the program following data presentation. *Panel B:* Output screen comparing data saved as a control experiment to the current experiment. The data are color-coded on the actual computer screen.

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Table 1. Summary of input parameters and output variables in the "experimental" simulations.

PROGRAM TITLE	INPUT PARAMETERS	OUTPUT VARIABLES
GLOMERULAR CAPILLARY DYNAMICS	Mean arterial pressure Afferent arteriolar resistance Efferent arteriolar resistance Filtration coefficient of the glomerular capillary wall	Renal plasma flow Glomerular filtration rate Flow entering the efferent arteriole Glomerular capillary hydrostatic pressure Glomerular capillary oncotic pressure Peritubular capillary hydrostatic pressure Hydrostatic pressure in Bowman's Space
PROXIMAL TUBULAR REABSORPTION	Mean arterial pressure Afferent arteriolar resistance Efferent arteriolar resistance Rate of sodium movement out of the tubular lumen and hydrogen ion into the tubular lumen during bicarbonate reabsorption	Renal plasma flow Glomerular filtration rate Flow entering the peritubular capillaries Oncotic pressure in the peritubular capillaries Fluid reabsorption in the proximal tubule The concentrations of bicarbonate and chloride within the proximal tubule Hydrostatic pressures in the proximal tubule and interstitium
THE DISTAL NEPHRON	Mean arterial pressure Circulating aldosterone level Circulating antidiuretic hormone level	Flow entering the distal nephron Solute concentrations entering the distal nephron Flow entering the medullary collecting duct Solute concentration entering the medullary collecting duct Urine flow Solute concentrations in urine
THE TOTAL NEPHRON	Mean arterial pressure Circulating aldosterone level Circulating antidiuretic hormone level Renal nerve activity Circulating renin level	Renal plasma flow Plasma sodium, potassium, urea and osmolar concentrations Urine flow Urine sodium, potassium, urea and osmolar concentrations Pressures and flows in the glomerular capillary Transport variables in the proximal tubule, distal cortical nephron, and medullary collecting duct
ACID-BASE BALANCE	Hemoglobin concentration Arterial carbon dioxide tension Fixed acid added or removed from the system	Blood and plasma bicarbonate concentrations Blood protein anion concentration pH Total anion concentration available for buffering Base Excess

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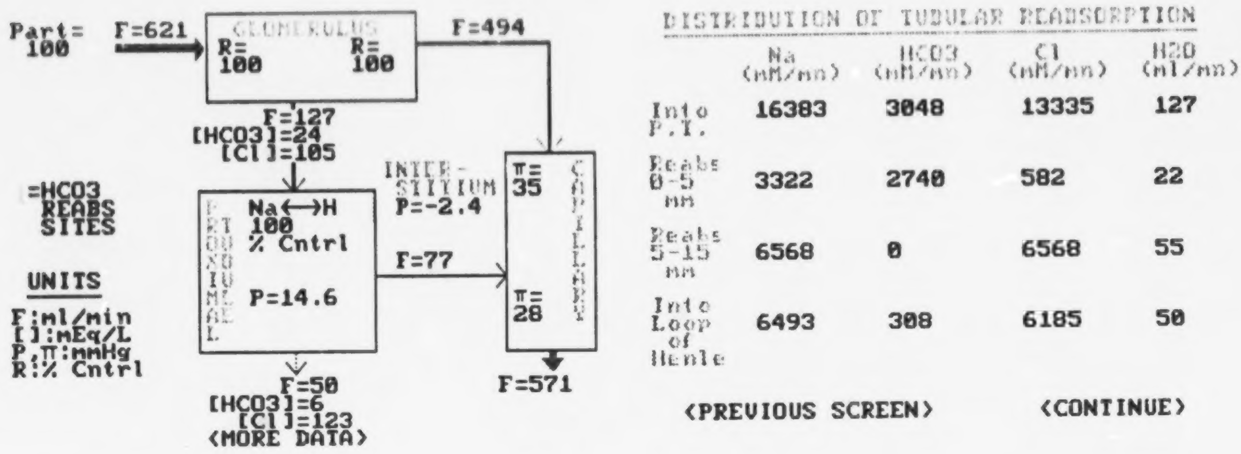

Part= 100
F=621
GLOMERULUS
R= 100
R= 100
F=494
F=127
[HCO3]=24
[Cl]=105
=HCO3 REABS SITES
INTER-STITIUM
P=-2.4
π= 35
CAPILLARY
PROXIMAL TUBULE
Na⟷H
100
% Cntrl
P=14.6
F=77
π= 28
UNITS
F:ml/min
[]:mEq/L
P,π:mmHg
R:% Cntrl
F=50
[HCO3]=6
[Cl]=123
F=571
<MORE DATA>

DISTRIBUTION OF TUBULAR REABSORPTION

	Na (mM/mn)	HCO3 (mM/mn)	Cl (mM/mn)	H2O (ml/mn)
Into P.T.	16383	3048	13335	127
Reabs 0-5 mm	3322	2740	582	22
Reabs 5-15 mm	6568	0	6568	55
Into Loop of Henle	6493	308	6185	50

<PREVIOUS SCREEN>
<CONTINUE>

FIGURE 8. Data screens from the Proximal Tubular Reabsorption program.

establish. Over 15 years of experience with students using our simulations in respiratory physiology has confirmed the efficacy of the guidelines that define the underlying philosophy of the overall package. Although specific pretest-posttest studies have not been conducted with the current package, an evaluation/critique process involving students and colleagues was employed during program development. As output screens were developed, they were tested to see if they conveyed the intended message by informally asking local students (undergraduate and graduate), laboratory technicians, and peers to interpret the pictorial. As each new simulation was completed, it was reviewed by faculty in the renal physiology groups at Tulane University School of Medicine and the Medical College of Wisconsin. Additional feedback was obtained from medical students at the Medical College of Wisconsin who used the package as part of their medical physiology course.

The water movement tutorial was evaluated by watching undergraduate, graduate, and medical students work through the program and, upon completing the program, interviewing them with respect to the mechanics of the program-student interaction, their understanding of the screens presented, and their overall understanding of material presented.

The programs were revised and refined based on the feedback received from

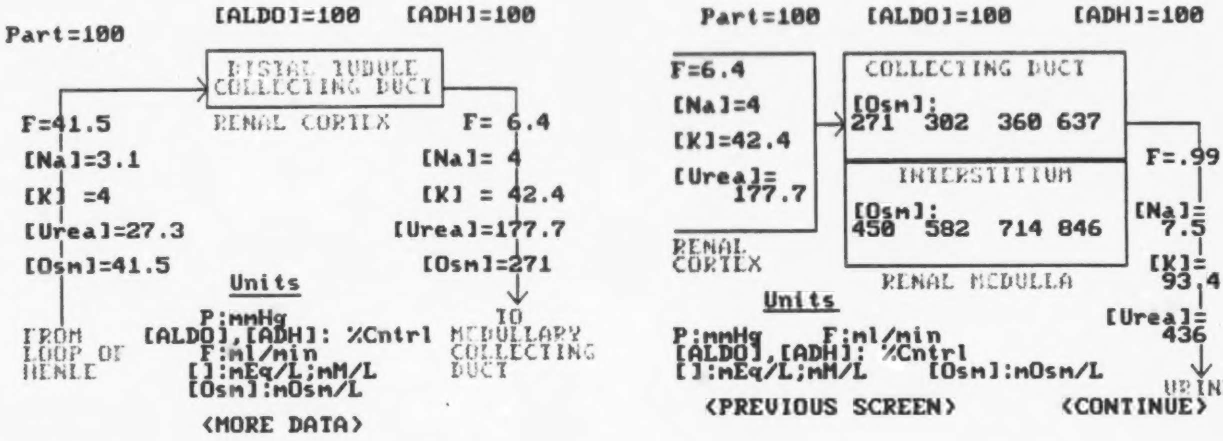
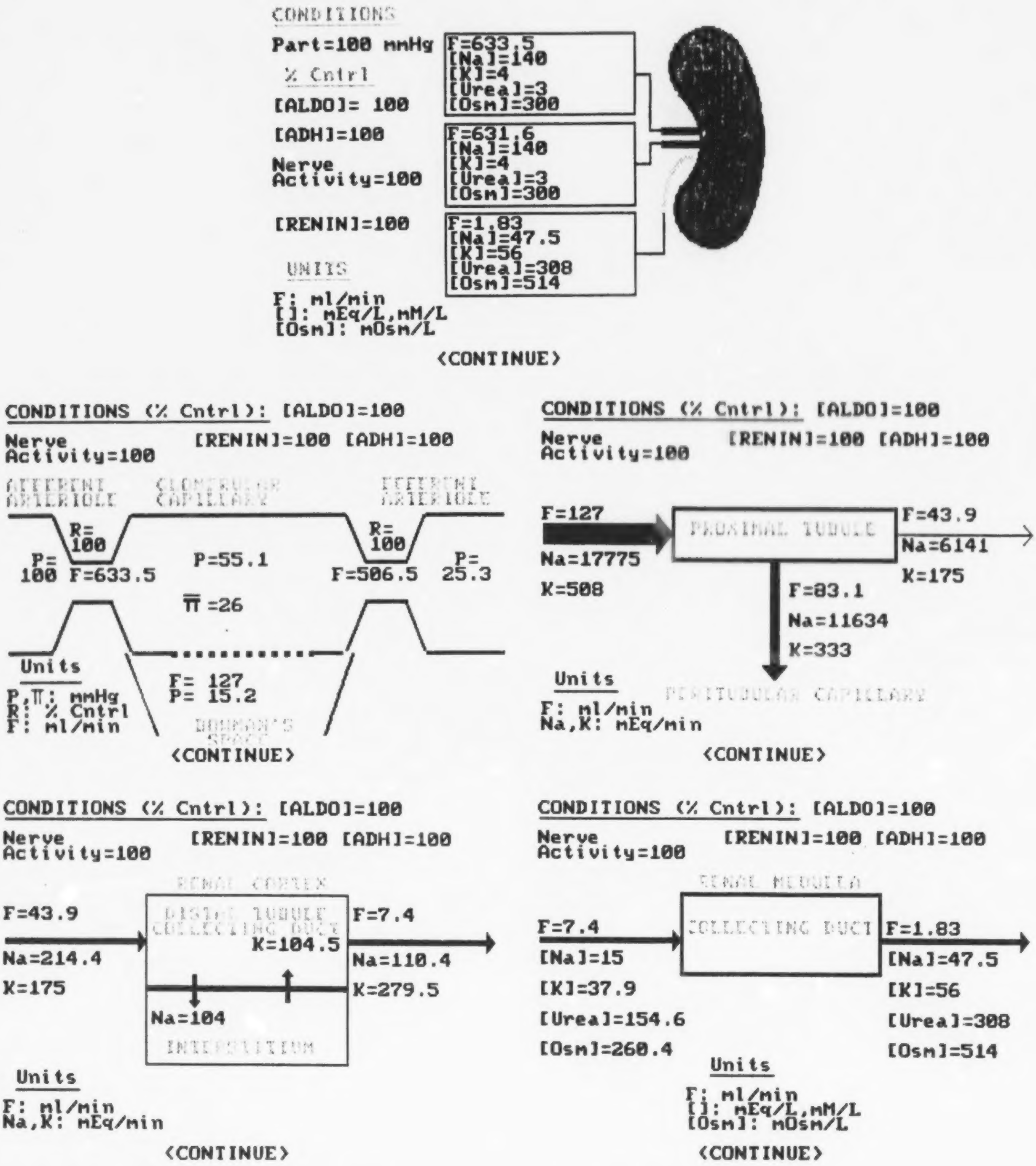

Part=100
[ALDO]=100
[ADH]=100
DISTAL TUBULE COLLECTING DUCT
RENAL CORTEX
F=41.5
[Na]=3.1
[K] =4
[Urea]=27.3
[Osm]=41.5
F= 6.4
[Na]= 4
[K] = 42.4
[Urea]=177.7
[Osm]=271
Units
P:mmHg
[ALDO],[ADH]: %Cntrl
F:ml/min
[]:mEq/L;mM/L
[Osm]:mOsm/L
FROM LOOP OF HENLE
TO MEDULLARY COLLECTING DUCT
<MORE DATA>
Part=100
[ALDO]=100
[ADH]=100
F=6.4
[Na]=4
[K]=42.4
[Urea]= 177.7
RENAL CORTEX
COLLECTING DUCT
[Osm]:
271 302 360 637
INTERSTITIUM
[Osm]:
450 582 714 846
RENAL MEDULLA
F=.99
[Na]= 7.5
[K]= 93.4
[Urea]= 436
URINE
Units
P:mmHg F:ml/min
[ALDO],[ADH]: %Cntrl
[]:mEq/L;mM/L [Osm]:mOsm/L
<PREVIOUS SCREEN>
<CONTINUE>

FIGURE 9. Data screens from The Distal Nephron program.



```
CONDITIONS
Part=100 mmHg      F=633.5
                   [Na]=140
 % Cntrl           [K]=4
[ALDO]= 100        [Urea]=3
                   [Osm]=300
[ADH]=100          F=631.6
                   [Na]=140
Nerve              [K]=4
Activity=100       [Urea]=3
                   [Osm]=300
[RENIN]=100        F=1.83
                   [Na]=47.5
 UNITS             [K]=56
                   [Urea]=308
F: ml/min          [Osm]=514
[]: mEq/L,mM/L
[Osm]: mOsm/L
              <CONTINUE>
```

```
CONDITIONS (% Cntrl): [ALDO]=100
Nerve             [RENIN]=100 [ADH]=100
Activity=100
AFFERENT      GLOMERULAR           EFFERENT
ARTERIOLE     CAPILLARY            ARTERIOLE
      R=                        R=
      100                       100
 P=                P=55.1                 P=
 100  F=633.5                   F=506.5   25.3
                   π̄ =26
Units
P,π: mmHg        F= 127
R: % Cntrl       P= 15.2
F: ml/min
                  BOWMAN'S
                  SPACE
               <CONTINUE>
```

```
CONDITIONS (% Cntrl): [ALDO]=100
Nerve             [RENIN]=100 [ADH]=100
Activity=100
F=127                              F=43.9
              PROXIMAL TUBULE
Na=17775                           Na=6141
K=508                              K=175
                   F=83.1
                   Na=11634
                   K=333
Units
               PERITUBULAR CAPILLARY
F: ml/min
Na,K: mEq/min
               <CONTINUE>
```

```
CONDITIONS (% Cntrl): [ALDO]=100
Nerve             [RENIN]=100 [ADH]=100
Activity=100
               RENAL CORTEX
F=43.9        DISTAL TUBULE      F=7.4
              COLLECTING DUCT
                     K=104.5
Na=214.4                         Na=110.4
K=175                            K=279.5
              Na=104
               INTERSTITIUM
Units
F: ml/min
Na,K: mEq/min
               <CONTINUE>
```

```
CONDITIONS (% Cntrl): [ALDO]=100
Nerve             [RENIN]=100 [ADH]=100
Activity=100
               RENAL MEDULLA
F=7.4         COLLECTING DUCT   F=1.83
[Na]=15                         [Na]=47.5
[K]=37.9                        [K]=56
[Urea]=154.6                    [Urea]=308
[Osm]=260.4                     [Osm]=514
               Units
               F: ml/min
               []: mEq/L,mM/L
               [Osm]: mOsm/L
               <CONTINUE>
```

FIGURE 10. Data screens from The Total Nephron program. After the primary data screen (top panel) is presented, the student can choose to view data from various components of the nephron (see text).

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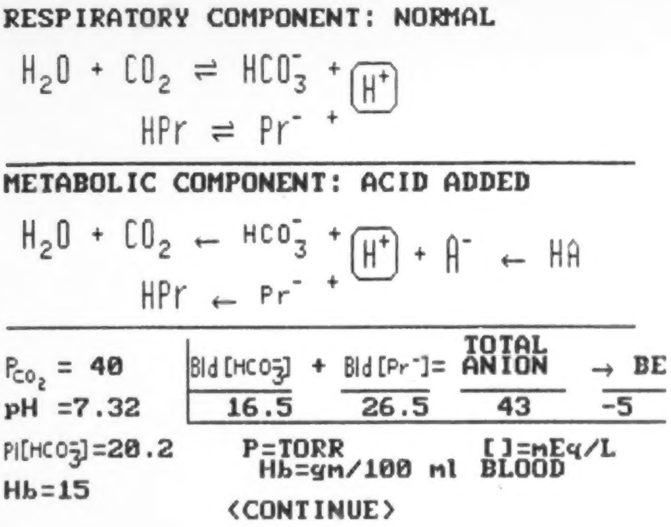

RESPIRATORY COMPONENT: NORMAL

$$H_2O + CO_2 \rightleftharpoons HCO_3^- + \boxed{H^+}$$
$$HPr \rightleftharpoons Pr^- +$$

METABOLIC COMPONENT: ACID ADDED

$$H_2O + CO_2 \leftarrow HCO_3^- + \boxed{H^+} + A^- \leftarrow HA$$
$$HPr \leftarrow Pr^- +$$

	Bld $[HCO_3^-]$ +	Bld $[Pr^-]$ =	TOTAL ANION	→ BE
P_{CO_2} = 40				
pH =7.32	16.5	26.5	43	-5

Pl$[HCO_3^-]$=20.2

Hb=15

P=TORR

[ ]=mEq/L

Hb=gm/100 ml BLOOD

<CONTINUE>

FIGURE 11. Primary data screen from the Acid-Base Balance program (see text).

these "evaluation" schemes.

PROGRAM AVAILABILITY

The complete renal package will be available for MS-DOS equipment in early 1993. The Macintosh version will become available by mid-1993. The philosophy governing distribution will be the same as that governing distribution of our earlier software. Permission will be granted to purchasers to make as many copies of the software as is necessary to service their student populations. Additional copies of the "laboratory" manual that accompanies the programs will be available at a nominal fee.

ACKNOWLEDGEMENT

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COMPUTERS IN LIFE SCIENCE EDUCATION, VOLUME 9 INDEX

- analog-to-digital conversion 3:43
- anatomy
  - colleagues 3:47
  - software 1:3
  - videodiscs 2:29
- annual report, NRCLSE 1:1-2

- biochemistry
  - colleagues 3:48
  - software 1:4
- biology
  - colleagues 3:49
  - software 1:5
  - videodiscs 1:30
- biotechnology videodisc 2:32
- botany
  - colleagues 3:51
  - software 1:6
  - videodiscs 2:32

- cell biology
  - colleagues 3:51
  - videodiscs 2:32
- clinical medicine
  - software 1:7
  - videodiscs 2:32
- CLSE
  - colleague directory 3:47-62
- colleagues
  - agronomy 3:47
  - anatomy 3:47
  - animal behavior 3:48
  - animal science 3:48
  - biochemistry 3:48
  - biology 3:49
  - biometrics 3:51
  - biophysics 3:51
  - biostatistics 3:51
  - botany 3:51
  - cell biology 3:51
  - chemistry 3:52
  - computer literacy 3:52
  - cytogenetics 3:52
  - cytology 3:52
  - dentistry 3:52
  - developmental biology 3:52
  - ecology 3:52
  - education 3:53
  - electron microscopy 3:53
  - embryology 3:53
  - endocrinology 3:54
  - entomology 3:54
  - environmental science 3:54
  - epidemiology 3:54
  - evolution 3:54
  - family practice 3:54
  - fisheries 3:54
  - gastroenterology 3:54
  - genetics 3:54
  - hematology 3:55
  - histology 3:55
  - immunology 3:56
  - instructional design 3:56
  - internal medicine 3:56
  - laboratory medicine 3:56
  - limnology 3:56
  - livestock production 3:56
  - marine science 3:56
  - medical technology 3:56
  - microanatomy 3:56
  - microbiology 3:56
  - modeling 3:57
  - molecular biology 3:57
  - molecular genetics 3:57
  - natural history 3:57
  - neuroanatomy 3:57
  - neurobiology 3:57
  - neuroscience 3:57
  - nursing 3:57
  - nutrition 3:58
  - oral histology 3:58
  - oral pathology 3:58
  - ornithology 3:58
  - parasitology 3:58
  - pathology 3:58
  - pediatrics 3:58
  - pharmacology 3:58
  - physiology 3:59
  - plant physiology 3:62
  - population biology 3:62
  - psychiatry 3:62
  - quantitative biology 3:62
  - research techniques 3:62
  - serology 3:62
  - statistics 3:62
  - taxonomy 3:62
  - virology 3:62
  - zoology 3:62
- cytology
  - colleagues 3:52
  - software 1:9

- data acquistion
  - software 3:44
  - systems 3:43

- educational issues 4:66
- ecology
  - colleagues 3:52
  - software 1:9
- evolution
  - colleagues 3:54
  - software 1:9

- forestry software 1:10

- genetics
  - colleagues 3:54
  - software 1:10

- health science videodiscs 2:36
- hematology
  - colleagues 3:55
  - videodiscs 2:37
- histology
  - colleagues 3:55

- James, Philip S 3:43

- Keeping Abreast of the Literature 1:1, 2:25, 3:41, 4:78

- laboratory protocols 4:69

- memory tests 2:26
- microbiology
  - colleagues 3:56
  - software 1:11
  - videodiscs 2:37
- miscellaneous software 1:17
- Modell HI 4:65

0742-3233/92/$0.00 + 2.00

- neuroscience
  - colleagues 3:57
  - software 1:11
- NRCLSE
  - annual report 1:1
  - reader survey 3:63
  - software evaluation submission form 1:21
- nursing
  - colleagues 3:57
  - software 1:12

- pathology
  - colleagues 3:58
  - videodiscs 2:37
- pharmacology
  - colleagues 3:58
  - software 1:12
- physiology
  - colleagues 3:59
  - renal 4:65
  - software 1:13, 4:65
  - videodiscs 2:37
- population dynamics software 1:17

- renal physiology 4:65
- Robinson, Dennis 3:43
- screen design 4:66
- Sipinkova, Inez 2:26
- simulation 4:65
- software
  - anatomy 1:3
  - biochemistry 1:4
  - biology 1:5
  - botany 1:6
  - clinical medicine 1:7
  - cytology 1:9
  - data acquistion 3:44
  - ecology 1:9
  - evolution 1:9
  - forestry 1:10
  - genetics 1:10
  - microbiology 1:11
  - miscellaneous 1:17
  - neuroscience 1:11
  - nursing 1:12
  - pharmacology 1:12
  - physiology 1:13, 4:65
  - population dynamics 1:17
  - zoology 1:17

- vendors
  - data acquisition systems 3:46
  - software 1:18
  - videodisc 2:29-39
- videodiscs
  - anatomy 2:29
  - biology 2:30
  - biotechnology 2:32
  - botany 2:32
  - cell biology 2:32
  - clinical medicine 2:32
  - ecology 2:35
  - dental health care 2:36
  - genetics 2:36
  - health science 2:36
  - hematology 2:37
  - microbiology 2:37
  - pathology 2:37
  - pathophysiology 2:37
  - substance abuse 3:39
  - wildlife management 3:39

- wildlife management videodisc 3:39
- Where are the Videodiscs? 2:29-39
- Where's the Software? 1:3-20

- Zahumensky, Jozef 2:26
- zoology
  - colleagues 3:62
  - software 1:17

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